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DIGITAL AUDIO™

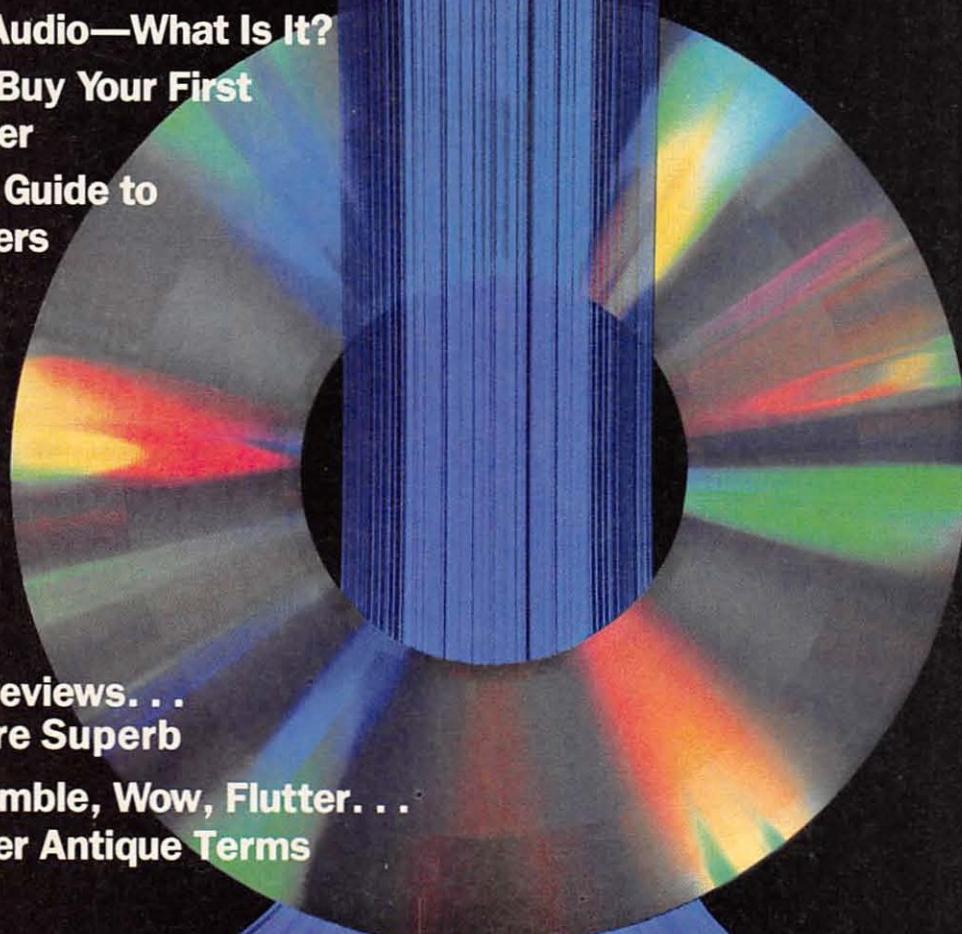
A WGE PUBLICATION

MAGAZINE

Digital Audio—What Is It?

**How to Buy Your First
CD Player**

**Buyer's Guide to
47 Players**



**19 CD Reviews...
Some are Superb**

**Hiss, Rumble, Wow, Flutter...
and Other Antique Terms**

Sound and Silence **The Secrets of CD**

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09
Magnavox, Sony, Toshiba Players Profiled
The Largest CD Listing Ever Published: 1400 Titles
Recording Digitally at Home: Encoders
Is the LP Record Dead?

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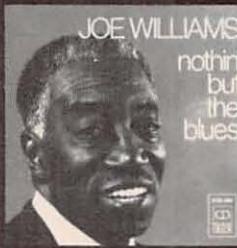
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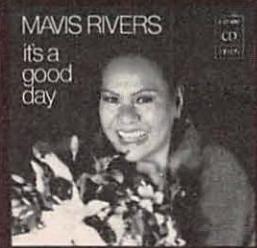
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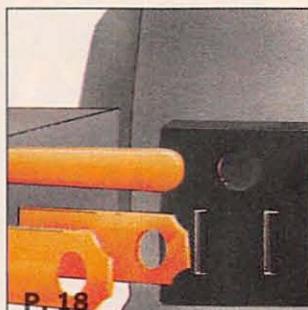
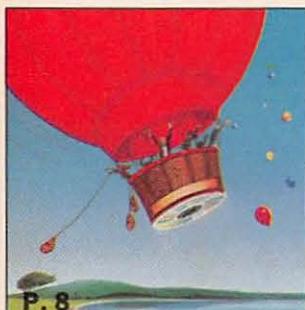
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DIGITAL AUDIOTM

MAGAZINE



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Sherwood announces the latest thing in second generation CD audio technology: Affordability



The compact disc just may be the most heart-stopping concept in sound since stereo. But the most heart-stopping feature of compact disc players has been their price. Now, with Sherwood's new CDP-100, you can relax about money and really get excited about sound.

A tradition of affordable excellence.

Sherwood is well-known for high-quality audio products at affordable prices. And our new CD player is no exception. While others were still on first generation models, we combined advanced second-generation performance with a no-nonsense array of useful features. And we did it in a way that not only makes sense, but saves you dollars as well.

Three laser beams for better tracking. Most CD players use only one laser beam. Sherwood put a **three-beam** laser into the CDP-100, because a three-beam system virtually eliminates distortion caused by spurious data from adjacent tracks.

Two filters, not one.

All CD's require filters, because the decoding of digital

sound generates a sampling frequency which must be filtered out, or distortions will be heard.

Other CD players use one very steep analog filter; this can cause phase distortion. Sherwood's answer is to use a digital filter to double the sampling frequency, then use a more gentle type of analog filter for reduced phase distortion. The result: better sound at less cost.

Easy-to-use functional controls.

Inserting a disc is easy, thanks to a "smart" motorized drawer under microprocessor operation. (It even knows if you accidentally put the disc in upside down.)

You can easily access any selection, and there's a two-speed fast forward and backward, so you can listen while you quickly locate the spot you want to hear. You can even set the CDP-100 to repeat the entire disc for continuous music.

Find out how advanced, easy to use, and affordable Sherwood's new CDP-100 really is at your nearest Sherwood dealer. To find him, call (800) 841-1412 during west coast business hours.



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Editor's Note

Digital audio is no flash in the pan. It's not long past its infancy, but it's already winning over people who never paid much attention to sound quality.

Digital Audio likewise won't be a flash in the pan. Our aim is to entertain, educate, and inform people who enjoy music. Each month, we'll be exploring the digital field, commenting on the players, and reporting the scores.

This Month

In our premier issue, for example, Robert Swartzendruber makes the concept of digital audio simple to understand ("Digital Audio Made Easy"), and Bob Leopold ("Digitizers: They Don't Miss a Thing") makes sampling theory a bit easier to grasp.

For the home digital recordist, Marc Wielage's "How to Record Digitally—At Home" shows you what you can do with a videocassette recorder and digital audio processor combination.

If you use a computer, you'll be interested in Bryan Brewer's column, "CD and Beyond." In his first installment, he describes some interesting possibilities for your CD player and computer. John Woram and Ken Pohlmann reflect on the digital/analog debate in their first columns, with Woram recapping the SPARS Conference from earlier this year and Pohlmann applauding the advent of digital.

All this digital coverage doesn't mean we've forgotten about analog; the 33½ record isn't ready for the graveyard, as Mike Apsey explains in "Is the LP Dead?"

If you're about to make a digital investment, "How to Buy Your First CD Player" and "Buyer's Guide to CD Players" will help. If you already have a player, you'll want to see "What's on CD"—our complete listing of titles, artists, and catalog numbers from every U.S. record company releasing CDs.

A Personal Favorite

If you look over our "What's on CD" list, you'll find recordings you wouldn't expect to see on CD. Unfortunately, one of my favorite recordings—Eric Carmen's *Boats Against the Current*—is not on CD and most likely never will be.

Boats Against the Current is fairly recent (1977), but I've already bought two copies of the LP (both now sound like a bowl of Rice Krispies) and a cassette. I'd buy it on CD, too, if it were available.

You're probably in the same boat; some of your favorite albums may never see the light of digital. That's a legitimate disadvantage to this brand new format.

The benefits of the CD, on the other hand, make it an obvious choice over any other type of recording. (I won't go through all the advantages now; they're listed in "Is It Live or Is It Digital?" on p. 46.)

Digital Audio is, of course, pro-digital, but we won't ignore the technology's weaknesses. One area that could stand improvement is software; many early CD releases were converted from analog masters, and it's obvious on some of them. Usually, an analog-to-digital (A/D) conversion greatly improves sound quality and clarity; hiss or distortion is indiscernible—or nonexistent. But that's not always the case.

CD players, on the other hand, are more consistent than discs. We have found audible differences between players, but, as many people have pointed out, the least spectacular CD players sound better than a turntable ever could.

Audiophiles with stubborn anti-digital beliefs are confusing. Are they *really* against digital, or are they against change? Digital is an advancement—an improvement over a technology that's been around for more than 100 years. Digital's benefits should be accepted and appreciated, and its faults should be recognized and improved upon by the industry.

Blowing the Lid Off Audio

Audiophiles should welcome digital; it's blowing the lid off the audio industry. Digital audio, in the form of Compact Discs and CD players, is making more people interested in recorded music—and how it sounds—than any prior development.

In short, the CD is stirring up a demand for quality in sound while it's becoming a mass market item. It's bolstering sales of videocassette recorders, speakers, amplifiers, audiocassette recorders, and even turntables, not to mention all kinds of software.

The Electronic Industries Association's "Consumer Electronics U.S. Sales Report" projects that 200,000 CD players will be sold in 1984 and 400,000 more in 1985. This means that artists, producers, and engineers will be paying closer attention to the recording process; they'll be using the digital advantage for pleasantly shocking innovations.

Earlier this year, I might have classified digital audio as a boat against the current. It's progressing so quickly, however, that the tide is turning.

—L.C.

DIGITAL AUDIO™

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Is the LP Dead?

by Mike Apsey

The Compact Disc has stolen the thunder from analog records, but that doesn't mean the LP is dead. Most people have too much invested in LPs, so the turntable will stick around (at least for awhile) as a complement to the CD player.

velocity, rotation speed, tracking weight (as high as 25 tons per square inch at the tip of a stylus 1mm wide), groove wear, skating, rumble, wow, flutter, variable pitch, hot and cold cutting lathes, surface noise, chatter, undulation, dry cut, cutover, cutting stylus whistle, grey cut, twinning, groove echo, groove horns, advance balls, microgroove, minigroove, dynagroove, orthophonic, cutting head turnover, diameter equalization, stamping, binders, fillers, mono compatibility, groove angle, pinch effect, tracking error, tangent error, side thrust, mechanical bias, stylus friction and temperature (as high as 2000 degrees in a new stylus while tracking), compliance, pickup arm resonance, overhang, and a book full of other headaches.

Many of these seemingly insurmountable problems have been solved. Exciting breakthroughs in LP disc recording/reproducing technology have been discovered and implemented. Certainly, the LP has come a long way from Edison's crude talking machine. As a matter of fact, today's LP mastered at half-speed doesn't sound all that bad.

Too Early for a Eulogy

So is the LP dead? No. The illness has been diagnosed, and time will do the rest. However, no matter how good the CD is—or becomes—LPs will be with us for a long time.

My LP collection goes back to the early '50s. In it are recordings that were poorly engineered and have been abused over the years. I'll never part with those obscure (but favorite) releases that never made it to the charts, or the songs that provided the musical score to my dating and dancing years.

Don't tell me I can't save or play those memories. Did "Gone With The

Wind" get mothballed when the Panavision Camera system was introduced? Nope.

So why all the fuss about the CD? Because several million people with several billion records know that many of the LPs they treasure will never make it to the CD format, and they're right. If many did make CD release, they would be revealed as questionable feats of engineering and mixing.

On The Trail of the Talking Machine

You can blame Thomas Edison for your giant LP collection, because he's credited with starting it all back in 1877. On the trail of the talking machine, he used the knowledge that sound moved air to move a diaphragm in and out. The diaphragm was connected to a needle, and the needle was positioned so that its in-out movements would create a groove of varying depth in a soft substance. The result was tinfoil cylindrical records. The whole contraption was mechanical. Electricity was in its infancy; the light bulb hadn't discovered Edison yet.

Tom's 1877 cylindrical record is described today (in engineering terms) as a constant velocity, vertically cut groove without tangent error. "Constant velocity," because it was a cylinder, not a flat disc, on which the outside grooves pass beneath the needle faster than the inside grooves; "vertical," because the needle moved up and down, not at right angles to the recording surface; "without tangent error," because the Edison needle traced across the cylinder without describing an arc (as with most turntables and pickup arms).

Just a year later (1878), Emile Berliner, working with his machinist Eldridge Johnson, conceived and cre-

Let's be fair to the LP. At its best, it can approach the sound of the Compact Disc, which is silent by a new definition; noise is now blamed on other parts of the sound system.

Quiet is a relative term. LPs are quiet. CDs are silent. If you're the type who boasts the latest in Dolby or dbx noise reduction for your transfers, your love of LP sound is in danger.

But life hasn't been easy for the LP. Manufacturers have had to overcome the mechanical and electrical problems associated with such things as lateral vs. vertical recording, groove

ated the "lateral disc recording." The record was no longer cylindrical, but flat. Berliner's grooves were a uniform depth, and the needle moved from side to side rather than up and down. There were arguments about which of the two methods produced the best sound.

Proponents of the cylinder complained that Berliner's disc introduced groove velocity error, and that high frequencies were lost as the stylus approached the slower-moving center of the disc. Since high frequencies require fast groove wiggles, the slower speeds near the center caused the wiggles to crowd together and distort because less groove passed by the needle and the groove couldn't store all the wiggles. The result was velocity error.

Still, the disc was more practical and economical than the cylinder, and disc copies could be stamped out like pennies from a die. Goodbye cylinder.

If the disc revolved fast enough, velocity error could be reduced to a level within tolerable limits, and the 78.26 rpm record (known as the "78") was born. It would be many years before disc mastering technology would allow the disc to turn more slowly at 45, and 33 1/3 rpm. Even with present technology, 16 2/3 rpm cannot shake the velocity error nemesis.

The Magnetic Tape Challenge

The LP is no newcomer to challenge. Magnetic tape is still chipping away at disc sales. In one sense, the history of audio has been the contest between tape and disc as each medium has struggled to outperform the other.

Although magnetic recording was conceived in 1900 by Vandelmar Poulsen, it wasn't until 1928 that German researchers announced a magnetic-coated, paper-based tape (thus, "tape" recorder). By the end of World

War II, the paper tape had become cellulose-based, and practical magnetic recording was underway.

The tape method of recording offered several advantages over the electrical transcription (LP): portability (disc cutting lathes were bulky, heavy, and nearly impossible to carry), compactness, freedom from processing, immediate playback, less expensive recording stock, a wider dynamic range, less distortion, and excellent sound. And, perhaps above all, you could reuse it.

The electrical transcription was to remain the only game in town for many years. Would magnetic tape eventually kill the flat disc? Would people continue to purchase records when reusable tape was available? Imagine—recording your own voice right in your home! The race was on.

But would tapes last? Could the flat disc be made to sound better than tape? Could the two technologies coexist? History shows that with only minor skirmishes they have coexisted.

By 1983: Tapes Outsell LPs

Meanwhile, back at the races, 1983 saw prerecorded magnetic tapes outsell LP records for the first time in history. Some industry watchers claimed that bootlegging finally caught up with the record companies. The record industry couldn't argue. Things were tough and getting tougher for the record labels, and "slump" became the adjective to describe LP sales.

Except for a few quality-conscious magnetic tape production houses, prerecorded tapes are poorly done. High-speed duplication, inexpensive tape stock, and low-grade cassette housings are to blame. Those who want higher quality reproduction should stick with the LP.

A bonus to buying records instead

of tapes is that, with a good cassette recorder, you have to play the LP only once to make a good tape (for your own use, of course). When the tape deteriorates, the LP can be called from the mothballs to make another copy. LPs last a long time in that scheme. Unfortunately, to get sound from the LP, you have to drag a needle through a groove—crude, but it works.

Some LP buyers use cassette decks another way. These folks build "mood" tapes by selecting songs from an assortment of LPs and transferring them onto one cassette. Now, a single cassette can maintain a mellow, swing, dance, or party atmosphere without sudden change. Also, LP selections that don't measure up can be skipped using this method.

Although even an average CD outperforms a good LP, CDs are now and will remain more costly to produce. Don't look for every artist on every label to earn CD fame—now, or in the near future. Since it takes a CD to show off a great mastering job, digital recording sessions will no doubt take CD priority, as will music whose enjoyment requires the CD's strengths.

CDs: Startling and Subtle

The CD advantage is both startling and subtle. Some music has so little dynamic range (all loud and no soft) that you couldn't hear the noise if you listened for it, except between selections.

My advice is to reassemble your listening components to make room for the new kid. If you don't have a turntable capable of tracking your LPs at 1.5 grams or less, get one, or you'll carve static into your antiques.

I won't give up my turntable and LPs, but somehow things have changed. My records aren't the same any more. Sound has grown up. □

Celebrating a New Issue

by Ken Pohlmann

Pass out the cigars and bottles of champagne—digital audio is taking off. In celebrating the explosion of this technology (and its namesake magazine), "ProAudio" columnist Ken Pohlmann shows why the audio professional has to decide *when* to go digital, not *whether* to go digital.

It's an exciting event to witness—the inauguration of a new magazine. I am involuntarily drawn to thoughts of grand ceremonies, or at least traditional gestures, on such an auspicious occasion. I imagine a spank on the bottom, then cigars all around. Or an exchange of rings, a kiss, then a quick plane to Acapulco. Or a smashed bottle of champagne, then a slowly accelerating slide down the ways.

A magazine? I don't know; maybe on the day the first issue is printed the editor goes home early and lies down in a darkened room, severely questioning the sanity of it all—especially a magazine on digital audio. I mean, talk about speculative ventures—absolutely no one really knows just how successful digital audio will be in the future, or whether it will be around at all.

Who knows—some scientific breakthrough could put analog audio back on the map. I'm sure that someone, somewhere, started *Eight Track Cartridge Magazine*, or maybe even *Quadraphonic Audio Magazine*.

On the other hand, some far-thinking genius, or lucky entrepreneur, started a small computer magazine with the guess that a boom in the hacker population was in the cards. That's the problem with speculative ventures: It takes a while to distinguish the millionaires from the crackpots.

A Guessing Game

The same guessing game is occurring with digital audio right now. It's impossible to predict the acceptance of a wholly new technology; many audio professionals have committed themselves to digital recording equipment, but it's the consumer, and ultimately the consumer's bank account,

that will determine success or failure and quantify the relative amounts of each.

Analog recording has served us well for more than 105 years, readily adapting itself internally to technological advances, yet maintaining an affordable price, thus paying tribute to the utility of Edison's groove. Is it reasonable to expect the rapid obsolescence of such a proven technology?

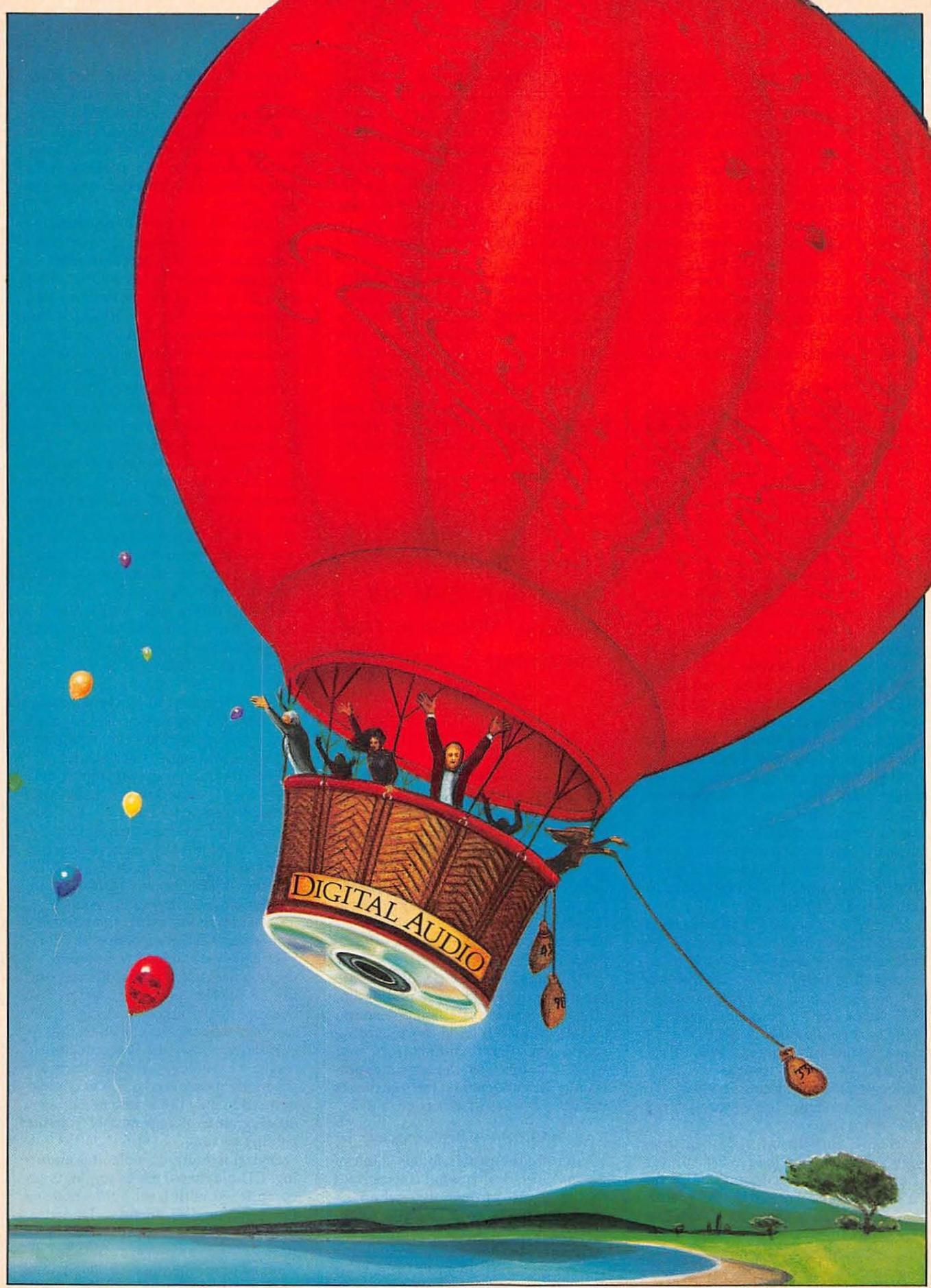
And what about the availability of program material? The first CD catalog

Manufacturers are predicting that within five years CD sales will surpass those of LPs and within ten years the CD will be the dominant medium for home, car, and portable listening.

issued last fall contained about 200 titles, whereas the LP catalog weighed in with more than 40,000. Last fall the total yearly worldwide production of CDs was only about 5 million; meanwhile Michael Jackson's *Thriller* album alone has sold more than 35 million copies—mainly on analog.

Yet the manufacturers are predicting that within five years CD sales will surpass those of LPs and within ten years the CD will be the dominant

Ken Pohlmann is Assistant Professor of Music and Director of Music Engineering at the University of Miami in Coral Gables, FL. He's earned bachelor's and master's degrees in electrical engineering from the University of Illinois. He works independently as a computer system designer, electronics and acoustics consultant and technical writer, and regularly risks his life astride large-displacement motorcycles.



medium for home, car, and portable listening. Is that reasonable? Would such an expensive and, in some circles, technically controversial medium so quickly gain supremacy? That, of course, is the question—one upon which millions of dollars of manufacturers' research and development money, and the hopes for the revitalization of the recording industry, rest.

In general, all we can say is that, given the acknowledged excellence and entrenchment of analog technology, if digital replaces analog as our audio recording and reproduction medium, digital must be damn good.

Potentials and Pitfalls

The question of just how good digital really is concerns everyone in the audio industry. It is critically important to understand the potentials and limitations of digital audio so we may fairly appraise its qualifications as a contender to analog and realistically map the progress of audio technology.

We must be able to ask this question: Is digital worth the added cost? In the future, will its cost be less and its abilities greater? If so, when is the time to invest? And speaking of the future, we must already begin to plan for it. Analog is a flexible medium and one given to change; for example, a single groove can accommodate one, two or four audio channels. But with digital technology the specification is more precise—and constraining.

If we anticipate future change, we must build it into today's specifications. Decisions on sampling rate, word length, format, error detection, and error correction might have to be lived with for a long time in a given format before we find justification to announce obsolescence.

Part of a technology's success is its longevity. No matter how many CDs are sold in the next five years, if an incompatible super CD is later marketed, we must conclude that the original CD was a failure because it was unable to accommodate change. We are back to our fundamental task of appraisal. To benefit from a new technology and shape its course wisely, we must understand the nature of the technology.

Where will digital audio technology's decisions be made? Consumers have the ultimate economic clout, yet it's the music recorded by the professionals that they listen to. If consumers do not like the way it sounds, nothing else matters; they won't buy it.

Ironically, consumers are more

adaptable to change in audio than professionals. In our recreations we are enamored of the new. In our professions we are sometimes suspicious of change, perhaps feeling threatened. A consumer merely listens and enjoys his music whereas a professional practices recording it every day. In the face of change he has to surrender an established technique and learn a new one quickly.

Also, a consumer goes digital with the purchase of a CD player or digital audio processor whereas a recording studio must go a million dollars into debt. Who do you think is more concerned about the future popularity of digital recordings?

If the professional is reluctant and continues to record via analog, where is the consumer's incentive to switch?

If the professional is reluctant and continues to record via analog, where is the consumer's incentive to switch?

I think you can see that the professional perspective of digital audio is a keystone in the entire venture and involves a complex decision. What the professional thinks about digital, how quickly he moves to embrace it, and how well he ultimately understands the new recording technique it demands all profoundly influence what we hear and on what medium it appears in the home.

This monthly column will examine the professional side of digital audio, offering slices of insight and wisdom, as well as gossip from the recording studio and the manufacturers that equip it. In this way, the listening community will understand the sometimes invisible origins of recorded music.

The Audio Pro's Preferences

What do the professionals think of digital? Specifically, what is important to the audio professional when he compares digital to analog? He examines many of the same qualities as the consumer, but with a different value system in mind. Overall, fidelity is

perhaps the main concern, but other questions, such as permanence, generation loss, editing and processing, and, of course, price all enter into the decision-making process. For a better understanding of the professional's perspective, let's consider these various criteria.

Fidelity is on everyone's mind—everyone from the concert-goer who desires acoustically excellent seats, to the home listener in his favorite chair precisely aligned between two loudspeakers. For the professional, fidelity means more than the pride and excitement in making a good recording; it also translates into client satisfaction and, thus, income. Moreover, the studio scene is intensely competitive; each studio tries to create a fidelity advantage to win clients.

If digital audio equipment sounds better or sells more records, then no matter what the cost, studios will pay for it. Does digital sound better? That, of course, is a loaded question. However, we may reasonably ask, are digital's performance specifications better than analog's? Seemingly, yes.

Digital offers flat frequency response from dc to half the sampling frequency, a very large dynamic range is realizable, distortion is very low, wow and flutter are confined to the minute variations in a crystal oscillator, channel separation is very high and skewing errors are very small, and tape print-through is nonexistent.

With traditional specifications, digital is clearly superior, but those tests were designed to measure the performance of analog devices. Is a different set of measurements needed to appraise digital audio devices fairly? No one really knows. Once again, greater understanding is needed.

Considerations other than fidelity sometimes take precedence; the compact cassette eclipsed reel-to-reel recorders because of convenience, and the LP pushed aside the 78 rpm disc because of longer playing time. Another important consideration is permanence. Analog is a notoriously fragile technology; analog discs are gradually destroyed by the very pick-up used to play them, and audio tapes disintegrate in storage merely from the passing of time.

Digital is more durable and enduring; CD playback, for example, is accomplished with laser light—nothing touches the disc surface. Likewise, digital magnetic recordings are more robust, and anyway could be reclaimed or recopied with minimal loss.

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Duplication brings us to another concern. Ironically, digital in the hands of consumer recording pirates might spell trouble. Whereas analog bootleg recordings are often of poor quality (owing to the inherent degradation in analog copying), digital recordings place master material in the hands of the pirates and offer the opportunity for making master-quality illegal copies.

For the professional, digital duplication is a critical asset. The path from analog master tracks to consumer tape or disc involves several generations of losses. With proper error detection and correction, digital can be copied with minimal loss; the consumer can listen to the same data present in the control room. Similarly, transmissibility is facilitated with digital technology; for example, satellite distribution of digital data promises to revolutionize music publication.

Full Fidelity

Parenthetically, I should mention a story currently making the rounds: A radio network was recently broadcasting a live rock'n'roll concert with digital recording data originating from the hall via satellite link. An engineer at a local radio station heard a noisy fader on the originating console. He called the network engineers long distance to inform them of the problem. The point is that with digital transmission we can all enjoy the full (or sometimes not so full) fidelity of the original music.

Aside from his bass and treble controls, the consumer rarely indulges in signal processing. However, the professional sometimes reaches nirvana amidst his maze of patchcords as he inserts modifying circuits in the signal path. Computer terminals replace patchcords in digital processing and bring a new dimension to the art.

When software, instead of hardware, is used to manipulate the signal, greater flexibility is obtained and only the creativity of the programmer limits the possibilities. Delay, reverberation, equalization, compression, expansion, phasing, panning, and any logical operation could be programmed and superimposed on the signal. Paradoxically, just as signal processing is entering its golden age of opportunity, many digital listeners who have suddenly heard the effect of such processing on the fidelity of the signal are calling for greater restraint in its use.

Error detection and correction fur-

ther demonstrate the utility of software, in this case to accomplish something not even technologically feasible with analog equipment. Data may be specially coded and distributed redundantly on the recording medium to permit the reconstruction of bad bits; in extreme cases, synthesis of new data may be accomplished to conceal defects in the medium.

Editing is another example of how software facilitates a task; electronic editing permits more sophisticated rehearsals of edits and merges—and accomplishes them much faster. The initial investment is much higher—an electronic editor versus a razor blade—but in a studio environment, where time is money, economics dictate surprising justifications.

The Bottom Line: Economics

The question of economics brings us to the bottom line. Digital is expensive; new technologies always are. However, digital technology promises to redefine the relationship of electronic technology and its economics.

For now, studio owners are faced with the awful question—not whether to go digital—but when?

In the past, the cost of electronics was essentially based on labor and parts. A professional tape recorder was more expensive because its circuits contained more parts and required more assembly than a consumer model.

With digital technology much of the important circuitry is contained on integrated circuits. To some degree, more complex circuit designs occupy greater chip areas, thus dictating greater cost, but cost is primarily a function of volume. If a product is mass-produced, the cost of manufacturing is distributed and the cost for a single chip can be quite low. Thus, sophisticated circuits may be integrated and sold cheaply if volume permits. So-called professional versions of electronic technology might cease to exist because small-quantity integrated circuits will not be economically feasible.

There is no such thing as a "profes-

sional" digital watch because they all use essentially the same chip. A special chip with truly professional features would be prohibitively expensive. With a generic chip, the only difference in cost is a gold case versus a plastic one. The same might be true for audio. The distinction between consumer and professional equipment might become blurred as mass-produced consumer products with sophisticated circuitry begin to set the true pace of technical development.

An early example of this is the Sony PCM-F1 digital audio processor, a device—designed for the consumer market—that surprised even its manufacturer by suddenly surpassing sales of existing professional gear.

For now, studio owners are faced with the awful question—not whether to go digital—but when? With formats and specifications still in flux, and with the shifting rules of the economics of technology, professionals have to have extreme bravery or heavy competition to take the plunge.

Digital Audio—Poised

In that respect we can perhaps generally summarize the state of digital audio by saying, simply, that it's poised. The hard facts of the marketplace and the less tangible criteria of higher fidelity certainly will combine to ignite the digital audio revolution.

Before it's too late, I should go on record (or Compact Disc) as saying—congratulations, digital audio, I eagerly anticipate your future.

Or has it already exploded? More and more, technology has proven its ability to catch us by surprise and reshape our lives. Before it's too late, I should go on record (or Compact Disc) as saying—congratulations, digital audio, I eagerly anticipate your future.

And on the auspicious occasion of the inauguration of *Digital Audio* magazine, I offer congratulations as well, and a sincere hope for a prosperous voyage. (Or, damn, I wish I had thought of that.) ☐

Digital SPARS with Analog: Round 1

by John Woram

The SPARS Conference produced a clear winner in the digital/analog debate: the new kid in town. But it may be a couple of years before digital audio captures the heavyweight title.

John Woram is president of Woram Audio Associates, a consulting firm specializing in studio systems engineering, design, and installation.

Dig out the newspaper reviews of yesteryear and see what the ancient scribes had to say about almost any newly emerging technology.

Transportation critics found no socially redeeming merit to the wheel. Their descendants announced that the steam engine was a technological failure—certainly no threat to the horse. The airplane? Nothing more than an adventurer's plaything.

Digital Audio Meets the Critics

And now, welcome to the world of digital audio—and the subject of technical criticism for the 1980s. As always, there are critics who pronounce it a disaster. As always, there are the others who tell us it's superb. As always, truth is caught somewhere in between.

For some, the digital debate makes interesting reading. For others, the interest is more of a financial nature. For example, consider the modern recording studio. A state-of-the-art analog control room can easily cost close to a half-million dollars.

The Society of Professional Recording Studios (SPARS) is a group of recording studios nationwide with a more-than-routine interest in the cost of control rooms and, therefore, in digital audio. Member studios have taken an interest in digital technology, not only for its own sake but also as a possible means of maintaining a competitive edge.

In Coral Gables, FL, the University of Miami has also taken an active interest in digital audio. The university's School of Music was the first in the country to offer a four-year degree program in music engineering technology. In recent years, the music engineering faculty has worked closely with SPARS on advancing the state of the recording art, and many Miami graduates have gone on to find jobs in SPARS studios.

The SPARS Show

And so it was fitting that SPARS and the University of Miami sponsored a joint conference on digital audio earlier this year (March 8-10), in an attempt to take a closer look at some of the contradictions surrounding the emerging technology.

The conference venue was the university's Gusman Concert Hall, where program director Ken Pohlmann got things underway with his "Introduction to Digital Audio." (By no coincidence at all, Pohlmann also writes the "ProAudio" column for *Digital Audio*.)

The proceedings started out on a tentative note, as Pohlmann did a



Chris Stone (Record Plant in Los Angeles), Richard Elen (Editor of Studio Sound in England), and Len Feldman (freelance author and consultant) closed out the SPARS Conference with "CD or Not CD, Was That the Question?"

quick audience spot check. Perhaps it was a case of opening-night jitters, but from the podium he noticed that half the audience looked like engineers who had been building digital consoles since the age of five. Even worse (Pohlmann could tell by the facial expressions), the other half were well-prepared to meet him in the parking lot if a pro-digital word leaked out.

How, then, to begin? Pohlmann announced he would be neutral. That lasted about five seconds:

"I should mention that...uh,...well actually, I can't be neutral. Digital is great. Digital is the future. Go ahead—quote me."

So much for objectivity. But perhaps Pohlmann was being objective. And perhaps that's the trouble with digital technology; it's objective, while music is subjective. Engineers and artists don't even use the same brain hemisphere, and perhaps digital is just too far off center to be accepted by the musical hemisphere, despite the accolades from the technical side.

Digital Is/Isn't Better Than Analog

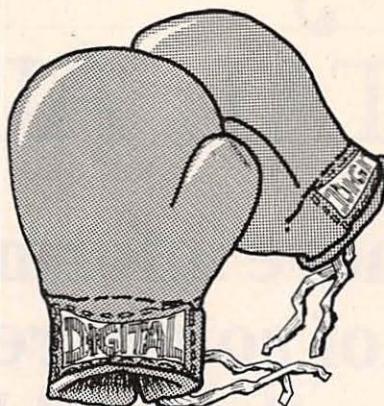
Perhaps. Perhaps? In the yes-no world of the binary digit, how can such a word exist? According to the latest scientific evidence, "Is digital really better than analog?" should be a binary-choice question, where Yes = 1 and No = 0. "Perhaps" scores about a 0.5, and should therefore be illegal.

On the other hand, perhaps the question itself is a bit premature (if not actually illegal). Perhaps it needs to be rewritten as: "Is digital really going to be better than analog?" If that question scores a tentative yes, then Pohlmann asks: "How long can I—should I—wait until I buy digital?"

Some buyers devote the better part of a lifetime to waiting for next year's improved model—the one with the lower price tag and higher quality. Digital procrastinators who fit this description may be in for a long wait. There are a lot of questions to be answered over the next few years, and—as with computer software—along with the answers will come new models, with even newer ones scheduled for later on. In other words, just "wait till next year," or better yet, the year after—or possibly, the year after that.

Professional Consumers?

As for price vs. quality, Pohlmann proposed an intriguing new world in



which consumer digital hardware might actually be better than what the professionals are using.

In the analog world, sophistication is pretty much a function of hardware. Generally speaking, more parts means better performance, with a price tag to match. For the consumer, there's

"...I can't be neutral. Digital is great," Pohlmann announced. "Digital is the future. Go ahead—quote me."

the stripped-down, more-affordable version.

Not so with digital, where sophistication comes on a chip. If you can amortize the R&D by selling lots of them, the unit price comes way down. So the mass-market world of consumer audio should be able to support big-ticket technology, while pro sales may have trouble underwriting product development costs.

Pohlmann cites the Sony PCM-F1 Digital Audio Processor as an example. Originally aimed at the high-end consumer market, it has enjoyed considerable success in professional recording sessions as well. In fact, recording engineer Roger Nichols did a series of more than two dozen live concerts throughout Europe last year, using two sync-locked F1s to create a four-track recorder. Of course, the pro often demands more than four tracks

on which to record and sturdier construction to withstand the rigors of studio life.

That's the hardware side of it, and here the separation between the amateur and the pro may still hold. But when it comes down to digital circuitry, further improvements are apt to be a function of support from the consumer marketplace.

As Pohlmann points out, there's no such thing as a professional digital watch.

Of course, sound recording is not quite the same thing as telling what time it is, and it will surely be a long time until consumer audio is ready to support 48-channel recording devices. But it won't be long (even on an analog watch) until consumer audio is ready to support the technology that goes into each one of those tracks—or at least into each stereo pair.

But first, the consumer will have to be persuaded that digital audio is worth the bother. If indeed it is. Certainly, the reviews have been mixed.

In Hauppauge, NY, Michael Tapes is president of Sound Workshop Inc., a prominent manufacturer of professional recording consoles. On one hand, Tapes is attracted to the latest technology. On the other, he is a musician who still listens to recorded music for pleasure—or at least tries to. He finds that with some digital recordings, the listening is no longer pleasurable.

Digital Audio on Trial

In search of an answer or two, Tapes presided over a SPARS Conference panel entitled "Digital Audio on Trial: If It's So Good, Why Is It So Bad?" To get things underway, he referred the audience to a paper presented by Professor P. B. Felgett¹ that made some comparisons between digital and analog recording. Of particular interest to the seminar were the author's comments on earlier advances in recording technology, some of which are paraphrased here:

In the communications sciences, requirements often can be specified in objective engineering terms. Therefore, it is possible (in principle) to verify by measurement if the specifications have been met. By contrast, consider applications that involve a subjective human response. Here, it may be as difficult to identify what needs to be specified as it is to fulfill those specifications once they have been chosen. Even in principle, mea-

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surement alone cannot determine whether the senses will be satisfied.

Fellgett compares the analog/digital debate to two earlier events in recording history. First came the change from acoustic to electrical recording in the mid-1920s. The earliest critics complained of the electrical recording's harsh, unmusical quality.

Years later, the transistor amplifier was introduced. Its highly praised "transistor sound" is now recognized as crossover and transient intermodulation distortion.

In both cases, apparently valid scientific data "proved" the superiority of new over old. Yet critics complained, and much later it was finally appreciated that the objective data had been misleadingly incomplete. There were indeed valid objections to the new technology.

Of course, by the time it was admitted that the new technology was not all-perfect, work was already underway to correct the defects. The critics were never given their due recognition—first because they were right when truth was unwelcome, and later because the corrections eventually obviated the criticism. Or as Fellgett heard one observer put it, "By the time people realized it wasn't good enough, it was."

Closed Ears, Closed Minds

The electrical pioneers may indeed have closed their minds and ears to criticism, and eventually electrical recordings did indeed surpass the acoustics (though some still argue whether transistors have surpassed tubes).

If digital eventually surpasses analog, it will happen because we have looked for its characteristic faults and cured them. Thus, the attitude that digital recordings are automatically better is not only absurd, it jeopardizes progress.

To put Fellgett's remarks into perspective, Michael Tapes challenged his panelists in "Digital Audio on Trial" to respond to an often-heard observation: Digital recordings are not emotionally pleasing. Analog recordings are. Why?

Panelist Roger Nichols, a recording engineer at Soundworks Digital Audio/Video Studios in New York, has nearly 150 CDs on his shelf. And some of them, he said, are bad—unbelievably bad. They're even worse when compared to the analog versions. Nichols would frequently discover that the

(analog) record producer knew little or nothing about the existence of the CD version.

Which brings up an interesting point. Can the same recorded source actually be used to satisfactorily produce both an analog and a digital product? Most recording engineers would probably say no.

Analog recording demands a certain amount of signal processing just to overcome the limitations of the medium. When this type of processing is heard over the digital medium, the result is rarely satisfactory. Engineers will have to learn to "uncompensate" as they begin recording. And that's easier said than done when the commercial success of the album still depends on the analog edition.

West Coast producer Bruce Botnick noted that one American record label's first batch of 50 or so CDs was manufactured in Japan without the parent company's participation. Many were made from equalized 1/4-inch analog cutting masters. These are tapes that are made as the LP master disc is being cut. Such tapes get all the equalization and compression that's needed—to make an analog long-playing record. Then a copy of this copy is sent abroad for CD production. In at least one case,

have to worry about such mundane things as differences between playback cartridges.

Still Too Early

But that's in the future. Tapes says he has three CD players in his listening room today. The same CD sounds different on each one. Worse yet, the differences are not linear. One player does better with low-level music than another, yet doesn't stand up as well on wide-range program material. Perhaps it is, after all, a bit early to make the definitive pronouncement on digital audio technology.

The long-playing record has been around for quite a while now. Before that we had 78s, and still earlier, cylinders. Since that first cylinder was engraved, the basic principle of cutting an analog groove into a plastic medium hasn't changed, although of course it's been continually refined. Today, that analog cutting stylus has been in operation for some 100 years. Within the same time period, a lot of other technologies have come and gone, yet until most recently the traditional analog record has not faced any serious contenders.

But now there's the Compact Disc. It's not surprising that within the last year or two it has not quite lived up to all the claims of its developers. What is surprising is that it has done so well, and so quickly. Surely, as Pohlmann said, it is the future. □

Producer Bruce Botnick pointed out that the Compact Disc is inherently capable of delivering the same performance at home that the engineer hears in the control room.

a CD was actually made from an analog copy of a copy of a digital master tape.

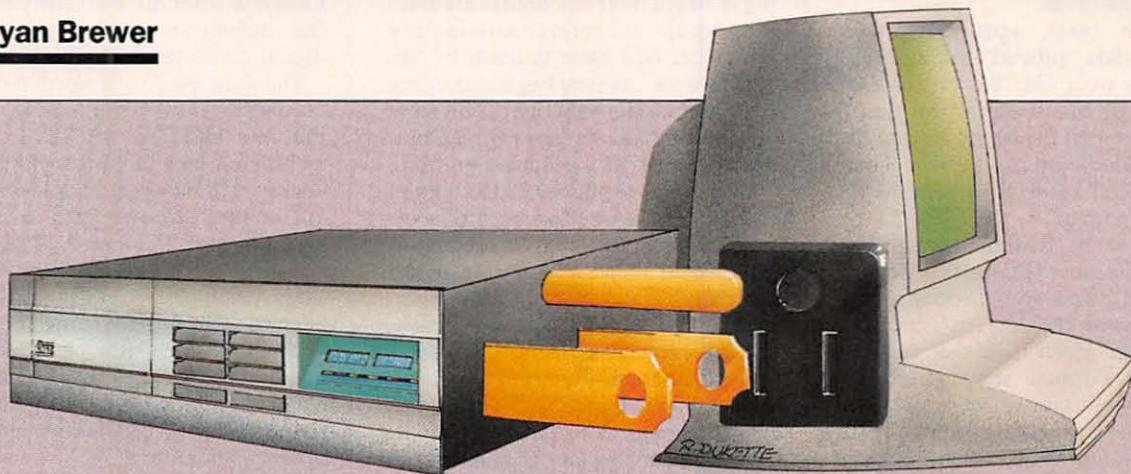
It's no wonder that such discs leave some critics a little less than thrilled. Yet Botnick pointed out that the CD is inherently capable of delivering the same performance at home that the engineer hears in the control room. For the first time, the listener won't



1. Fellgett, P.B., "Some Comparisons of Digital and Analogue Audio Recording," *The Radio and Electronic Engineer*, Vol. 53, No. 2., pp. 55-62, February 1983.

The CD-Micro Connection

by Bryan Brewer



Compact Disc players have been introduced as audio components, but they have all the makings necessary to become a micro "peripheral," an external device you can connect to a computer for input or output of data. In fact, Sony and Philips have already announced agreement on a standard format for storing computer data and programs on Compact Discs. This new CD-ROM (Read Only Memory) format will ensure a consistent data format among all disc producers.

So what's the appeal of a CD player as a computer peripheral? The main advantage is storage capacity. When a disc's 16 gigabits (billions of bits) of raw data are translated into formatted data that a personal computer can use, the result is 550 megabytes (550 million characters) available on a single Compact Disc. Even though the data capacity is reduced (because of CD modulation and redundant data for error detection and correction), 550 megabytes is still more than 1000 times the capacity of a high-density floppy disk. [Note: computer disks are spelled with a "k," Compact Discs with a "c."]

Another critical feature is random

access. Unlike a tape player, a CD player doesn't have to fast forward or rewind to find the desired track. It never takes more than three seconds to reach data stored on any part of a Compact Disc. That's important for microcomputer users who are accustomed to quick access of data stored on disks.

Unlike a computer disk drive, a CD player cannot write or record information on the disc. Expensive mastering and duplicating equipment is used to produce Compact Discs in volume. It may be five or more years before an economical version of a "read/write" CD player is available. In the meantime, there's a lot of attraction to having one of your audio components double as a storage device for your personal computer.

You can store a lot of information in 550 megabytes. Each character (a letter, number, punctuation mark, or symbol) requires one byte of storage. So if you figure a full single-spaced typewritten page has no more than 5500 characters, one CD can hold the information contained on more than 100,000 pages!

Shopping on a CD?

Imagine what could be put on a CD: an encyclopedia, a telephone directory, the Sears catalog, professional journals, newspapers, all the Haydn symphonies, a complete set of foreign language dictionaries—any large amount of information you might want to use as a reference database. You'll also need software so you can locate information in these large databases, but that can be stored on CD, too. You simply load this access software into your PC's memory whenever you use the database on the CD.

How do you connect your CD player to your personal computer? Well, the CD-Micro "interface" has not been announced. So far, the only official word from Sony or Philips, the licensors of the CD technology, is an agreement on the CD-ROM data format. However, if you take a look at the rear panel of several Sony models (such as the 610ES), you'll see a plug marked "Accessory Connector" covered by a small plastic cap. The owner's manual states that this plug is for connecting equipment that will become available

in the future, but doesn't offer any details. You can be sure that this will include an interface cable to connect to a computer.

The Sony Accessory Connector is a 26-pin male plug. One of the most common connectors on a micro is the 25-pin RS-232C used for a serial interface. All it would take to connect the two is a cable that converts the wiring from the 26 pins on the CD to the 25 pins on a micro. Of course, the micro software would need to use the proper codes for accessing the data on the CD, but it's unlikely you would need to install an extra controller board in the computer to complete the connection.

Of course, the connection won't do you much good until you can buy some discs with data stored in the CD-ROM format. Perhaps the first ones available will store reference material, such as encyclopedias or dictionaries. Or maybe retailers will get into the act and offer large catalogs on disc. It depends on the consumer acceptance of the CD-Micro interface and the eventual price of producing the discs. And since any updates would require a new disc, applications will probably be limited to those where the information isn't changed very often.

Using your CD player to access an encyclopedia or a mail-order catalog is getting pretty far afield from CD's primary audio purpose. And therein lies perhaps the most exciting prospect for the CD-Micro connection: interactive audio.

Remember that CD players are random access, with a maximum three seconds access time. Some programmable players let you preset the sequence of audio cuts on a disc. With the CD-Micro interface, a program in the computer can control the timing and sequence of the CD audio output. This is different from simply using the CD for data storage—it's using the CD to play prerecorded sound that's coordinated with the action of the computer program.

The Gift of Gab

One possibility is the talking computer. It gives audio responses based on your interaction with the program in the computer. Imagine using an educational program on your micro and *hearing* the instructor lecture and give directions. Instead of tediously reading text on an eye-straining com-

puter screen, you're taking in information audibly—at a rate that studies show is more than twice as fast as reading!

Answer a question and the instructor tells you—either on your headphones or through speakers—whether you're right or wrong. Then the program branches you to the next sequence based on your response. Want to hear a segment again? Simply press the proper keys to have the audio repeated. And while you're listening to the material, the screen can act as an animated blackboard, displaying key words, concepts, or diagrams to illustrate and reinforce what you're hearing.

The talking computer can be applied to all kinds of software, to give directions for using a program, to warn of errors, or to tell the user what is happening during processing. But remember, digital audio can produce very high fidelity sound. There's no reason not to include music, singing, sound effects—in short, any sound that can be played back to enhance the experience of using a computer.

Combine that with color graphics on a micro and you have a whole new generation of video games with realistic sound. In fact, as video, audio, and data all become more digital, the distinction between education and entertainment on computers will blur even more. Why not an interactive "radio drama" to teach history? Or a course in music that plays selections and allows you to analyze them? Or a game that teaches you a foreign language, complete with accurate pronunciations? Or a guided meditation program where you control the flow and pace of the audio material?

CD-Micro Team: Irresistible Appeal

The Compact Disc will make all this possible... in time. The first inklings of the CD-Micro connection are beginning to surface, and it will take awhile for the software/audio combination to follow. Once all the pieces are available, the established distribution network for audio will ensure wide exposure to the public. And the appeal of having a superb audio component double as a computer peripheral will probably be irresistible.

One of John Naisbitt's 10 "Megatrends" is the complementary growth of High Tech and High Touch. When

new technology emerges, it is usually accompanied by some humanizing factors that make it more acceptable to people. For computers, those factors may well be the warm tones of the human voice and the soothing sounds of pleasant music. That's the High Touch of the CD-Micro connection. ☐

Storing Data On Disc

Information is recorded on a Compact Disc as a series of microscopic pits on a series of circular tracks spaced only 1.6 micrometers apart on each revolution. Generally speaking, each pit represents one bit of information. More than 16 billion bits (gigabits) of raw data can be encoded on a 12-cm disc.

How do 16 gigabits of raw data get reduced to 550 megabytes of computer data? Part of the answer lies in the way a CD disc is originally encoded. The current technology uses a process called EFM (eight-to-fourteen modulation). For every eight bits of computer data, 14 bits are stored on the disc.

These extra six bits are used to actually expand the play time for audio material. But even though they don't increase the storage capacity of computer data, the extra six bits must be included so the CD player can decode the signal. That leaves you with an encoded storage of about 9.14 gigabits, or 1.14 gigabytes (eight bits = one byte).

For the CD-ROM format to store 550 megabytes, roughly half of the encoded storage capacity of 1.14 gigabytes must be used as redundant data. This provides for error correction and detection beyond that afforded in the CD audio storage. Sophisticated mathematical algorithms embedded in the LSI (Large Scale Integration) circuitry of the CD player ensure that the data stream is virtually error-free when it is passed on to the computer through the CD-Micro connection. ☐

Bryan Brewer writes interactive computer-based instruction courses in his "electronic cottage" near Mt. Rainier, Washington.

Breaking Up Over CD

by Steve Birchall

Q: Why does my TV picture (or my next door neighbor's) break up when I use a CD player?

Bob Knight
Lawrenceville, NJ

A: This is one area where we have found significant individual differences from brand to brand among CD players. Although all must meet the minimum standard, most exceed it by a wide margin, and, even in a technology-laden home, cause no problems. Only a minority of CD players operate at the emission specifications.

Most have adequate shielding, but a few do not. The cause is the weak radio frequency (RF) emissions generated by microprocessors. CD players fall under the same FCC regulations that apply to personal computers and video games.

According to the definitions, a "Computing Device" is any unit that has a clock rate above 10 kHz and uses digital techniques. Since the sampling rate for CDs is 44.1 kHz, the players are subject to this set of rules. Without proper shielding, they could cause reception problems on FM, ham and CB radios, or at the low end of the VHF TV band. UHF isn't affected.

The FCC subdivides Computing Devices into two categories: Class A for business equipment and Class B for home equipment. Examples of Class A devices are electronic cash registers, studio quality digital recorders, and dedicated word processors—anything not likely to be, nor intended to be, used in a home. Class B devices are consumer products such as radios, TV sets, home computers, and of course, CD players.

The Class B standard is the more rigid of the two, because in a typical

home situation, a greater variety of devices are operated simultaneously. This may lead to mutual interference among various home electronics.

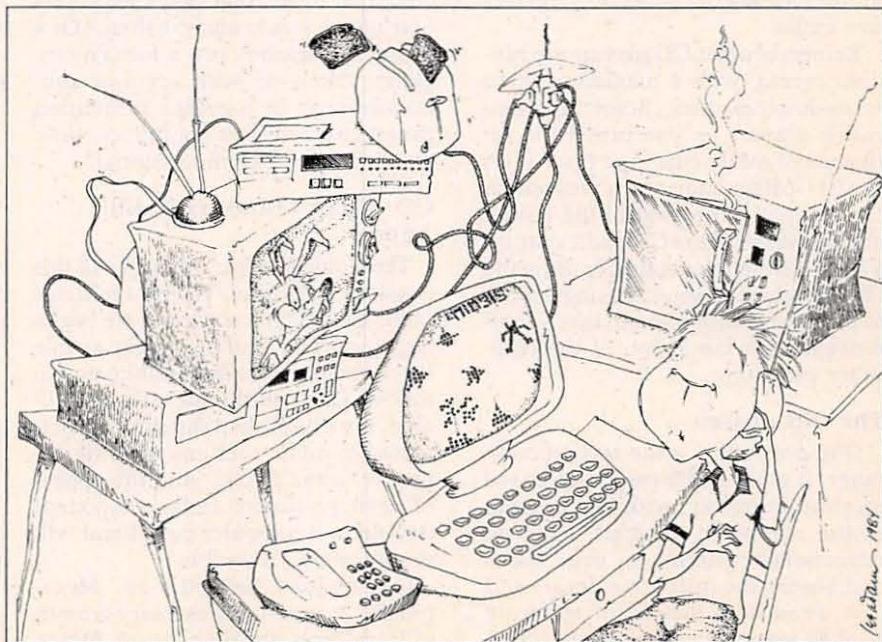
A technology addict like me, typically has the TV on (with the sound off) while working at the computer, listening to Compact Discs, taping a movie from the cable for later viewing, and answering the cordless phone while dinner is cooking in the microwave. (My pacemaker sometimes gets confused by this complex RF field.)

A TV or radio must not create problems for another set in an adjacent room. However, in an office, no one cares if a personal computer "jams" a nearby TV receiver because people normally don't need to watch TV in an office. Those who like listening to a radio while working at a word pro-

cessor might be out of luck under the current law.

People living in apartments, townhouses, or other high-density urban housing may have some problems. The FCC standard is set so that a Class B Computing Device will not interfere with the operation of other devices when they are more than 10 meters (ca. 33 feet) away and separated by at least one wall. If you (or a neighbor) have a TV or FM receiver in the next room, you may have problems with some CD players.

If you do have interference problems, you have little choice but to select another brand or model that creates less interference. When choosing a CD player, you might arrange to borrow a dealer's demo overnight to see if it will work satisfactorily within



AMANDA McBROOM

LINCOLN MAYORGA

HARRY JAMES

THELMA HOUSTON

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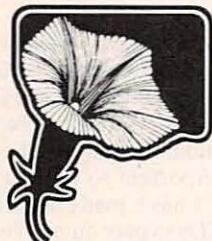
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Four of these Compact Discs will be made from direct digital transfers of the digital master tapes and will be of special interest to audiophiles who will no doubt want to compare them with the direct disc version. We believe that the knowledgeable listener with excellent analog disc playback will perceive that for the last measure of accuracy and resolution the direct disc version contains the most musical information. We are confident that those who have chosen the Compact Disc format for its convenience, absence of surface noise, and its relative absence of wear will recognize the merits

of Sheffield Lab's recording technology and will find our Compact Discs to be the most sonically satisfying of their collection.

Our release of eleven Compact Discs, including a compilation disc ("Crème de la Crème"), highlights thirteen years of Sheffield Lab recording technology. Five of the original albums received Grammy nominations for engineering excellence. Our expertise in developing microphones and electronics to best capture the true musical energy of our artists is clearly evident on these Compact Discs. We are excited that this new format will bring our best efforts to a totally new audience, who will hear unedited, live performances of popular music for the first time.

Sheffield Lab audiophile recordings and Compact Discs are available at fine audio stores and select record stores.

SHEFFIELD LAB INC., POST OFFICE BOX 5332, SANTA BARBARA, CALIFORNIA 93108
(800) 235-5737; Except California, Alaska & Hawaii (805) 969-4744 Telex 658343

your particular housing, lifestyle, and family situations. Other solutions are to use a rooftop antenna or to subscribe to a cable service.

Q: Why do I have trouble recording CDs on my audio cassette recorder?

Linda Carruthers
LeRoy, NY

A: Several problems can arise. One is that the CD, at 90 dB, has a much greater signal-to-noise ratio (s/n) than any analog cassette recorder (at 65 dB with Dolby B in circuit) can handle. Many of the better models have a limiter, which you may or may not want to use. Others have Dolby C and/or dbx noise reduction, which can bring the s/n closer to the performance level of the CD.

If the particular CD you are trying to record has a significant high-frequency content at high amplitude, you may encounter distortion and loss of highs on the tape. The reason is that intense high-frequency program material can act as an erase current as the

signal passes from the tape head to the oxide. This has long been a problem with transferring analog discs to cassette—the CD just presents a greater problem to the recorder.

Still another potential problem is interference between the CD's 44.1 kHz sampling rate (and any unsuppressed harmonics of it) and the tape recorder's bias frequency (usually around 60 to 90 kHz). If the CD player does not filter out the 44.1 kHz component (and its harmonics) adequately, and if your preamp actually passes it through to the tape deck, the beat frequencies caused by their interaction could create some bizarre sounds.

Q: What are those new "CD Ready" cassette tapes and why are they different?

Ara Kingman
Minneapolis, MN

A: Can you buy anything today that is not "digital ready"? Two years ago, the blank tape manufacturers would have had to find some other buzz phrase to promote their newest form-

ulations—and did. They claim an improvement of as much as 4 dB in s/n for the new tapes, which is truly substantial and worth crowing about. But 4 dB doesn't quite close the gap between analog cassette technology and the CD. It helps, and I wouldn't hesitate to use the hottest tape available to make a copy of a CD.

From my own experience, I would recommend using the best grade of tape available. Although the magnetic characteristics are important, the mechanical properties become even more so. You will be much more aware of dropouts, because that is about the only kind of glitch you will hear. Use a tape that does not shed oxide readily—particularly over time and repeated use.

Also, the internal friction of the shell and its mechanism may contribute to wow and flutter, especially after repeated playbacks cause it to wear. The mechanical factors always have been what separated the sheep from the goats among blank cassette tape, and now they will become even more important to critical listeners.

I have made several tape copies of CDs to play on my "walkperson." Obviously the analog tape copy doesn't sound as good as the CD itself, but that ultra-clean, undistorted sound, all that extra ambient information, and the complete absence of record noise make listening through headphones sheer luxury. Now the only remaining glitch is an occasional dropout on the tape.

Q: What can I do about the heartbreak of Digital Fever?

Barry Frickmen
Charlottesville, VA

A: Take two LPs and go to bed.

"Audio Advice" is a monthly forum for readers to ask questions and broaden their knowledge. Our goal is to promote understanding and increase awareness of digital audio.

Digital Audio's technical editor, Steve Birchall, will answer questions related to digital technology and music. Steve will attempt to untangle technical problems (within reason), and explain digital audio terminology.

Send questions to:

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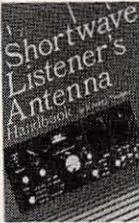
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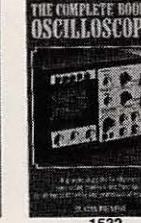
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New Products

edited by Patricia Flanagan



ReVox Enters the Race

Studer ReVox America has entered the CD market with the B225 CD player. Typical of Studer's attention to quality construction, the "industrial-strength" B225 features a phase deviation of less than 1 degree.

The B225 offers a front-loading drawer, 19 programmable tracks, and an infrared remote control that operates all of the other ReVox components. More than 50 commands are possible with the remote control.

The B225's dimensions are 17½ inches W by 4¾ inches H by 13 inches D, and it weighs just under 20 pounds.

Suggested retail price: \$1150
Studer ReVox America Inc.
1425 Elm Hill Pike
Nashville, TN 37210

The ReVox B225, inside and out.

Soundcraftsmen Unleashes The PCR 800 II

Soundcraftsmen presented the PCR 800 II 555-watt-per-channel basic stereo amplifier at the Summer CES. Soundcraftsmen calls it the highest-powered stereo amplifier presently available.

The PCR 800 II utilizes two completely independent power supplies, dual power transformers, two-speed cooling fans, and dual ac power switches.

The PCR 800 II consists of two PCR 800s and a PC-X2 front panel, which converts the combination into a single stereo amplifier when used with any Soundcraftsmen DX Series preamp.

Each channel operates in bridged mono mode, producing 555 W at 8 ohms, with no more than 0.05 percent distortion from 20 Hz to 20 kHz, and it employs the latest MOSFET output circuitry.



Soundcraftsmen's high-powered PCR 800 II retails for \$947.

Current-limiting has been eliminated from the design, giving it sufficient headroom for digitally recorded music. Total weight is under 40 pounds.

Suggested retail price: \$947
Soundcraftsmen
2200 S. Ritchey
Santa Ana, CA 92705



You can watch the data go by on Pioneer's P-D70.

Suggested retail price: \$749.45
Pioneer Electronics
1925 E. Dominguez Street
Long Beach, CA 90810

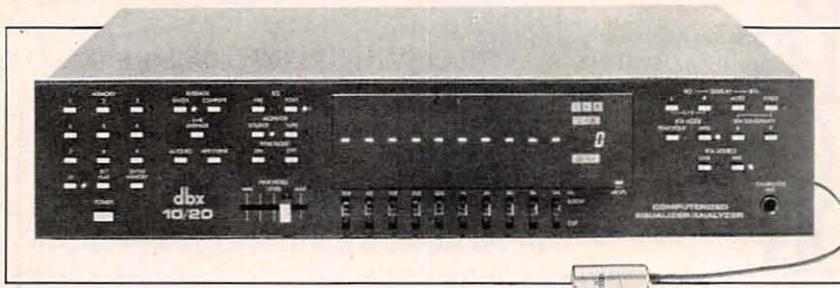
Pioneer's Pioneer CD Player

Pioneer's first Compact Disc Player, the P-D70, features a number of convenience functions, as well as a flashy light show. Pioneer claims the flashing lights (located on a 12-segment LED indicator next to the pause, play, and stop buttons) display, in the Binary Mode, bits of data as they are read from the CD and processed for analog output. In the Peak Display Mode, peak levels are shown on the indicator.

The P-D70 has a four-way display showing the index number, total play time in minutes and seconds (with total number of tracks), remaining play time, and the track number in play.

Other features include a three-spot laser beam system, a front-loading disc drawer, memory programmability for 10 selections, a slow scan with audible output, and music search by either track number or elapsed time.

The P-D70 weighs under 17 pounds and measures 16½ inches W by 3¾ inches H by 11¼ inches D.



The dbx 10/20 retails for \$500 less than the 20/20, the first computerized equalizer.

dbx: More Equalizing At a Lower Price

Similar in design to the industry's first computerized equalizer—the dbx 20/20—the new dbx 10/20 offers additional features and a lower price tag than the earlier version. Its suggested retail price of \$1200 is \$500 less than the 20/20.

The 10/20 automatically equalizes the left and right channels, individually or in combination, with microprocessor accuracy. It can analyze as many as 10 locations within a room and automatically adjust equalization for flat response in seconds. This is virtually impossible to attain with conventional equalizers.

The digitally controlled 10/20 Computerized Equalizer/Analyzer, with its calibrated microphone and built-in pink noise generator, can automatically "voice" a room and store as well as recall the equalization settings.

Its real-time analyzer function, which also serves as a sound level meter, provides continuous information on the music energy in each frequency band. A display

of 275 LEDs visually portrays the functioning of the real-time analyzer by providing instantaneous readout of musical content in each frequency band. It also can display any equalization curve stored in memory.

Suggested retail price: \$1200
dbx Inc.
71 Chapel Street
Newton, MA 02195

dbx's Traffic Controller

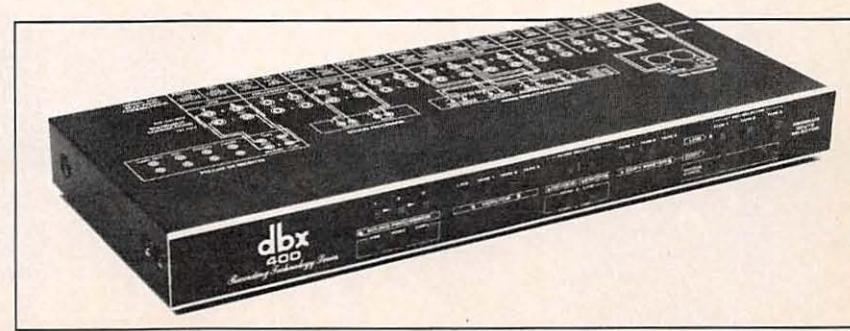
A new switching system that simplifies operation of multicomponent stereo systems joins the dbx product line. The dbx Model 400 program route selector accommodates three sound processors, a dbx encode/decode tape noise-reduction system, and three tape decks.

Other features of the Model 400 include a color-coded LED display to indicate clearly which interconnections have been made. Hard-wired circuitry ensures no signal loss.

The low-profile, 1¾-inch H by 19-inch W, rack-mountable design coordinates with the rest of the dbx noise-reduction and signal processor product line.

Suggested retail price: \$229
dbx Inc.
71 Chapel Street
Newton, MA 02195

The dbx Model 400 offers simplified operation for complex systems.





WHO WOULD HAVE THOUGHT IT COULD TRIGGER A REVOLUTION IN SOUND.

Remember when laser technology was the stuff that made for good science fiction?

Well, it isn't fiction anymore.

Because Pioneer has harnessed the same laser that used to blow space creatures away, to blow you away.

With the P-D70. A compact disc player that

reproduces music so realistically you'll think you were at the original recording session.

Since a sophisticated optical laser never makes contact with the disc, all surface noise from dust and scratches is eliminated.

And because the music is processed digitally, distortion is essentially nonexistent, resulting in the drama of a live performance.

In addition, the P-D70 contains all the ultra-convenience features of a player so sophisticated and futuristic.

But of course, it's what you should expect from a compact laser disc player from Pioneer.

After all, we developed laser optics and digital electronic technology for our revolutionary LaserDisc™ video systems.

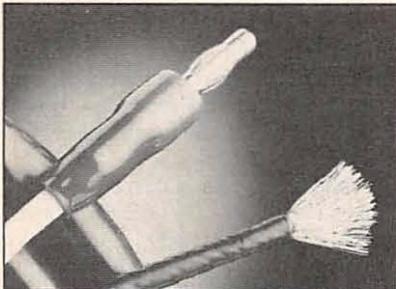
And that was back when most people were of the opinion that lasers were more fiction than science.



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Interlink 4: More dynamic range.



Monsters on the Loose: Cable Connection

For the first time, Monster Cable, with its Interlink 4, is offering a product in five pre-cut lengths. Designed exclusively for audio components, Interlink 4 utilizes the same "Bandwidth Balanced" principles as Interlink Reference, but at a reduced price.

Using two symmetrical multigauge signal-carrying conductors inside a non-signal-carrying shield, the bandwidth balanced technology optimizes signal flow in both amplitude and phase.

Monster Cable says that Interlink 4 offers greater dynamic range, increased clarity, and lower distortion. The suggested retail prices are: ½-meter pair, \$20; 1-meter pair, \$25; 1½-meter pair, \$30; and 20-foot pair, \$66. Interlink 4 is also available in unterminated custom lengths for \$1.25 per foot.

"Time Coherent" Monsters

Monster Cable's Powerline 2 uses a "Time Coherent" winding configuration for its top-of-the-line speaker cable. Powerline 2 replaces the original Powerline and has a lower price.

Powerline 2: Ultra low noise.



The new winding configuration is designed to eliminate phase inaccuracies and to align the high and low frequencies to travel at the same speed through the cable for improved frequency response and imaging. Powerline 2 isn't available in pre-cut lengths. Its suggested retail price is \$2.25 per foot.

Professional Monsters

Monster Cable also boasts five new ProLink high performance musical instrument and microphone cables designed to improve sound quality on stage and in the studio.

The three new ProLink Series M.I. models and two mike models are shielded for ultra low noise and hum. Each cable is fully terminated with precision connectors and covered by scratch-proof chrome plating.

The M.I. and mike series are offered in per-foot and 10-, 15-, and 20-foot prices. Prices range from \$1.50 per foot to \$6 per foot for the M.I. Series, and \$3 per foot and \$6 per foot for the Microphone Series.

Monster Cable
101 Townsend Street
San Francisco, CA 94107

JBL Introduces Light Metal

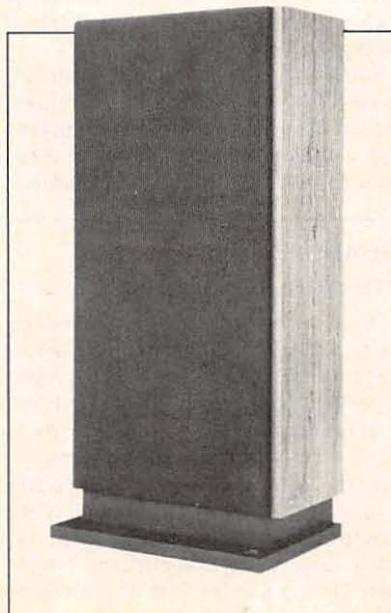
JBL's TLX Series, a five-model home loudspeaker line, features titanium laminate (TLX) tweeters and laminated high-polymer midrange and low-frequency drivers at affordable prices.

According to JBL, titanium is ideal in diaphragm construction or in any application requiring lightweight rigidity and durability. The TLX tweeter has the structural integrity of a hard dome, plus the damping characteristics and smooth response of a soft dome, JBL says.

The TLX Series consists of five models: the two-way, 6½-inch J216A; the two-way, 8-inch J220A; the three-way, 8-inch J320A; the three-way, 10-inch J325A; and the three-way, 10-inch floor-standing J350A.

Suggested retail prices range from \$99.95 each for the J216A to \$319.95 each for the top-of-the-line J350A.

JBL
Harman International
8500 Balboa Blvd., P.O. Box 2200
Northridge, CA 91329



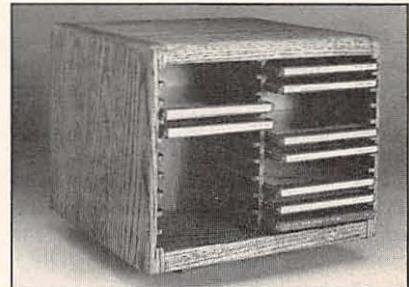
Nagaoka Cleans Up

Since CDs use a laser optical reading system to retrieve the digitally encoded information, foreign particles (finger prints, liquids, tobacco smoke, dust, dirt, and other airborne contaminants) can cause "mis-tracking." Nagaoka's Cleaning System offers a solution to this messy problem.

The Nagaoka CD-1100K Compact Disc Cleaning System consists of three parts: The first is the CD-1000S Spray, a non-corrosive, non-abrasive solvent that removes the foreign matter without damaging the CD's protective surface.

The CD-1101C Cleaner is a soft lamb's leather pad, which is used radially (across the disc, rather than in a circular pattern). The buffer and cleaner are stored in the CD-1101B base/holder, which doubles as a storage case and a holder for the discs during cleaning.

Suggested retail price: \$30
Nagaoka & Co., Ltd.
Distributed by Microfidelity Inc.
14 Van Zant Street
Norwalk, CT 06855



Sonrise on the Horizon

Your Compact Discs can be stored conveniently in the Mirrormont III Compact Disc storage cabinet from Sonrise. The Mirrormont III stores up to 40 discs (20 per side). Discs on the back rotate smoothly to the front at the touch of a finger.

The cabinet is 11¼ inches W by 10 inches H by 11¼ inches D. It's available in solid oak or walnut and can be stacked to multiply storage capacity.

Suggested retail price: \$69
Sonrise Audio Systems
13622 NE 20th Suite F
Bellevue, WA 98005

IBM: Let's Make a Deal (For 1.5 Million CD Players)

by W. Charles Doherty

Big Blue Buys Into CD System

What are those boys in Boca Raton up to? According to an article in *Info-world*, the Entry Level Systems (personal computer) Division of IBM has placed an order for 1.5 million (that's right, *million*) Compact Disc players from an unspecified Japanese vendor. At present, Big Blue is staying mum about the source (Hitachi?) and the intended application.

It's a safe bet that a sudden craving for rock 'n' roll isn't what's behind the deal. Obviously, IBM plans to use the CD as a mass-storage device for the PC. So why all the secrecy?

Each CD can store 550 megabytes of data—far more than the capacity of a standard floppy disk. And, the CD is much more durable. Compact Discs sneer at magnetic fields that would send a floppy disk to an early grave.

What's more, the CD player can read the information five times faster than the floppy drives. The main drawback is that it's a read-only medium, at least for the present. The main advantage is that large databases, such as a year of the *New York Times*, could be sold inexpensively.

Watch for more developments from JVC and Sony in the near future. Rumor has it they, too, are developing a standardized operating system for microcomputers to use the CD as a storage medium.

Denon 1: Designs on Auto CDs

Several manufacturers showed prototype automotive CD machines at last winter's Consumer Electronics Show, but all the machines experienced problems when bumped or shaken. Now, a new transport design from Denon promises to make CDs practical for automobiles—and offer better tracking for home systems at the same time.

A scaled-down version of the transport in its \$8500 professional machine, Denon claims, offers a greater resistance to shock and acoustic vibration than is possible with conventional transports.

Rather than moving the laser on guide rails, as with most machines, Denon uses die-cast aluminum pivots and a linear motor with servo-feedback to position the tracking laser.

Denon 2: Current Record

Denon now holds the record for the longest musical piece currently available on a single CD. Beethoven's *Ninth Symphony* (Denon CD-7021) features 71 minutes of music on one side; most other discs rarely hit 60 minutes.

By the way, the CD system supports a maximum of 74 minutes playing time per side in its present form. So don't expect anything much longer than Denon's release in the foreseeable future.

An additional benefit of this new design is its ability to move from any position on the playing surface to any other in less than 2.5 seconds—considerably faster than most other CD players.

This new design is currently available in Denon's DCD-1800 CD player, which retails for \$900. There have been hints the transport will soon find its way into a new machine retailing for about \$500.

NARM Compact Discussion

The Compact Disc was the focal point of the annual NARM (National Association of Record Merchants) meeting, the country's largest gathering of record distributors and retailers.

An informal survey conducted by the president of a major audio equipment manufacturer revealed that CDs account for 3 to 5 percent of total sales on a national basis. Some retailers attributed as little as 1.5 percent of sales to CDs, while others claimed more than 8 percent of sales came from digital recordings.

Almost everyone agreed that the limited number of currently available titles was a problem, but that CDs would be an important part of their future marketing plans.

Big Brother Is Watching You

Did you know that the federal government is keeping track of people who own CD players?

It seems the Food and Drug Administration has a number of regulations on the use of lasers, including those in CD players. Since some lasers can be considered hazardous, Big Brother wants a way to contact owners if some important development comes along.

Manufacturers are required by law to keep the name and address of everyone who purchases one of their machines. This information usually is taken from warranty cards and is held by the manufacturer, not by the government itself. I wonder what the National Rifle Association would have to say about this.

In case of enemy attack, the government may instruct us to remove the CD's laser and use it to shoot down attacking aircraft. In the meantime, I don't want to hear of anyone using his CD player to cut cars in half or to disintegrate barking dogs.

"HERE ARE THE DENON REFERENCE CD'S. AND HERE ARE THEIR REFERENCES."



"...a sense of air around the instrumentalists that one ordinarily encounters only in live performances."

Fanfare Magazine, September/October 1983



"...the most convincing reproduction of recorded music I've heard yet..."

"...for a Schubert Ninth that really sounds like an orchestra playing I think this issue has no equal."

Ovation Magazine, November 1983



"For anyone starting a compact-disc collection, I can think of no better release with which to begin."

"The Smetana Quartet's version of Beethoven's Op. 59, No. 1...one of the most exciting versions of that particular work ever recorded."

Ovation Magazine, November 1983

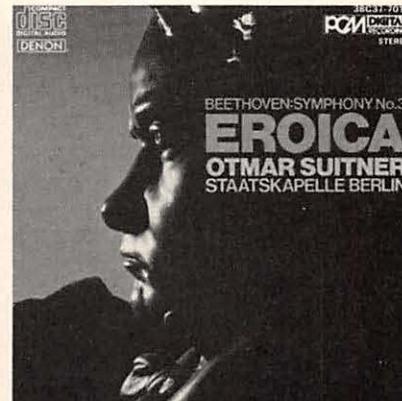


"This is one of the most exciting organ records ever made."

"...completely hypnotizing."

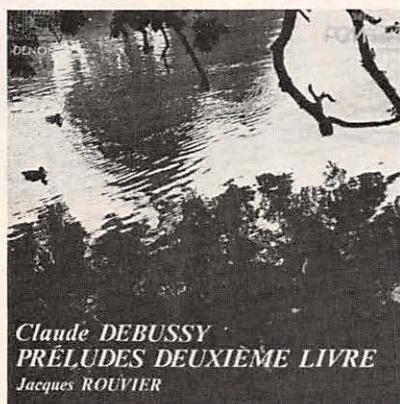
"...uncannily like being in Freiberg's beautiful cathedral, listening in person to the splendid organ..."

Ovation Magazine, October 1983



"A superb reading as a digital LP, the bass definition and general clarity are even greater on the CD, with no loss of warmth."

Ovation Magazine, November 1983



Claude DEBUSSY
PRÉLUDES DEUXIÈME LIVRE
Jacques ROUVIER

"...Jacques Rouvier is a superb technician, with tremendous power and solidity and remarkably precise fingers."

"The sound is excellent: the overall acoustic is warm, the dynamic range is wide, and the Steinway's bass is reproduced with stunning fidelity."

Ovation Magazine, November 1983



BEETHOVEN
STRING QUARTET No. 8 IN E MINOR
"RASUMOVSKY No. 2" Op. 59, No. 2
SMETANA QUARTET

"...compelling...uncommon fire and precision." "This excellent performance is a revelation in CD!"

"...the most natural string-quartet sound I have yet heard on a recording, creating the impression that the players are sitting right in the room with the listener."

Ovation Magazine, November 1983



NEW RELEASE!
Beethoven: Symphony No. 9 ("Choral")
Staatskapelle Berlin, Otmar Sutner, cond.

Complete
on one disc:
over 71
minutes!

DENON IMAGINE WHAT WE'LL DO NEXT.

CES Report: Show-stoppers in Chicago

by Larry Canale

Anyone who doubts that the Compact Disc market is catching fire should have elbowed through the Summer Consumer Electronics Show in Chicago. CDs and CD players were the stars of the show.

A record total of 98,257 people attended the CES, a trade show for electronics dealers, retailers, and buyers. What they saw—spread out in two buildings (McCormick Place and McCormick West) and several hotels—was a never-ending barrage of new products from

audio, video, telecommunications, and computer companies.

With 1381 displays exhibiting every electronics product you can think of, it's hard to imagine a single product line stealing the show. But, thanks to several digital developments, that's exactly what the Compact Disc did.

Spotlight on CD

Cost and cars were the main reasons. CD players have dropped to a price range that makes them ready for the

The Compact Disc had its name in lights at the Fisher booth. Below, "a few" of the 98,257 CES spectators.

Fueling the acceptance of digital audio at the Summer CES were car Compact Disc players and price reductions on home CD players. And CDs were selling like hotcakes—right from the CES exhibits.



mass market. And digital autosound finally has become a reality—not just a concept portrayed in prototypes.

On the software side, CES produced some pleasantly surprising developments. Doug Sax, who didn't have many nice things to say about Compact Discs earlier this year, released 11 Sheffield Lab CD titles in May and brought them to sell at CES.

Shoppers swamped Sheffield Lab's display room, and the CDs in stock didn't last long; about 5000 discs were

sold. Telarc Records also reported substantial sales, going through more than 3500 CDs.

American Gramaphone sold out of its first release on Compact Disc, *Fresh Aire I* (which had become available only two days before CES started). Mobile Fidelity was another company that experienced better-than-brisk CD sales at the show.

Laury's, a Chicago record store boasting an 1100-title CD catalog, reported a 32 percent increase in CD sales at its Michigan Avenue location ("just" four blocks from McCormick Place) during CES week.

What makes the news of hot-selling CDs at CES so interesting is that the customers were all buyers and retailers who can usually obtain CDs at cost. Telarc, Sheffield Lab, and the other record labels selling CDs at CES had a two-disc-per-customer limit, so the industry people (the retailers as well as the audio professionals) were buying the discs for their personal use.

Shouting About It

The "Compact Disc Workshop" reflected the CD excitement. Panelists included Emiel Petrone (PolyGram), John Briesh (Sony), Hans Gout (Philips), Harlan Lippincott (Magnavox), Art Shulman (Laury's), and moderator Rich Warren (WFMT, Chicago).

Shulman goaded dealers and retailers attending the seminar to get hustling with promotions. "Every record store in America should be shouting to its customers about CDs," he said. "... This is not an audiophile medium; this is a mass medium."

"What we are all selling," Petrone said, "is the whole CD system, and the real driving force is consumer awareness." Lippincott agreed, adding, "The mass market is ready for CD."

The seminar produced questions from the audience about the quality and consistency of software and hardware.

"There are sonic differences between players," Lippincott said. "The worst-sounding CD player I've heard is much better than any turntable I've heard."

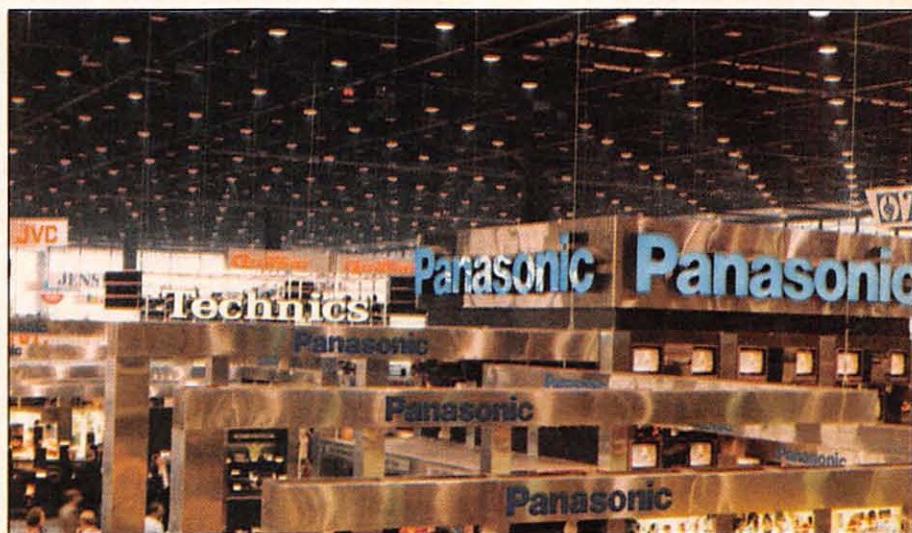
"The CD's level of performance is far higher—and it's far more uniform—than any hardware and software we've seen," offered Sony's Marc Finer.

Prices: Consumer-Friendly

CD players became even more consumer-friendly as new breakthroughs in retail prices were announced. Yamaha attached a new price tag—\$499—on its CD-X1; it now retails



The four-day Summer CES (June 3-6) drew 98,257 electronics dealers, retailers, and buyers.



Technics and Panasonic, divisions of Matsushita, were neighbors at CES. Technics displayed its SL-P7 and SL-P8 CD players, but it was the SL-P15 that attracted the most attention. This multi-disc player stores 51 CDs and can access any of them within 20 seconds.

for \$100 less than its introductory price of last year. Yamaha's fancier model, the CD-2, was released in May '84 at \$699. That price also was slashed \$100, to \$599, at CES.

Later this year, Sharp Electronics will ship two new CD players, the DX-600 and DX-100, with \$399 price tags. Emerson, meanwhile, is preparing to release a mid-size CD player priced in the \$300 to \$400 range. It should be shipped early next year.

Several other attractive new models were announced, including Luxman's DX-103, Teac's PD-11, Kenwood's DP-700, Denon's DCD-1800, NAD's

5255, and Onkyo's DX-100. And Studer/ReVox released its first CD player, the B225.

Driving With Digital

The arrival of CD players for the car added to the excitement about digital audio. Sony, which introduced car CD player prototypes at the Winter '84 CES in Las Vegas, uncovered the real thing this time: the DIN-sized CDX-5 Compact Disc player and the CDX-R7 AM/FM CD player. No price range has been established for either player.

The CDX-5 and CDX-R7 are small enough to fit "into most foreign and

domestic cars," Sony claims, but sturdy enough to withstand potholes and high temperatures.

The car players feature dynamic range of 90 dB and 0.007 percent total harmonic distortion; an automatic music sensor (AMS) for skipping up or down; a music scan control for audible fast forwarding or reversing at 10 times normal speed; and repeat modes for single tracks or entire discs.

Mitsubishi, Pioneer, and Technics also displayed auto CD player prototypes. All three players will be available early next year.

New Ideas in Digital

Technics, besides showing off its car player prototype, displayed some other innovative products, most notably the SL-P15 multiplay CD player and the SL-P50 professional CD player.

The SL-P15 carries a surprisingly low price. For \$1500, you get a machine that can load and program 51 CDs (50 discs can be programmed while one is playing). It features a 20-second maximum access time between tracks on any disc.

The CDs are stored in a motor-driven removable cartridge. An optional interface module allows you to incorporate



Sony announced a new dimension in auto audio: a pair of car CD players. The CDX-R7, above, includes an AM/FM stereo and fits into most foreign and domestic cars.

additional equipment to program up to 255 discs.

The SL-P15 also features a multi-function fluorescent digital display that provides a numerical readout of the track number, playing time, and index of the selections on the CD being played. It comes with a wireless remote control.

The SL-P50, designed for audio professionals and disc jockeys, features a built-in monitor speaker combining left and right channels. It has a separate volume control that automatically shuts off when the player is on-line.

A portable computer-sized unit, the SL-P50, features a display section that faces the operator. It offers left and right VU meters that show pre-fader levels for each channel. And an error indicator lets you know if a disc has been loaded incorrectly or if it is scratched or soiled.

At the Kyocera booth, "the world's first intelligent Compact Disc player" was demonstrated by Computer Systems Management. The set-up included Kyocera's first-generation CD player, the DA-01 (a second-generation model was being displayed as well), an Apple II (a IIe also will work), an Apple II disk drive, and a video monitor. (An IBM PC interface will be available soon.)

The "smart" CD player is useful as a training tool in language studies, music appreciation, and music theory. In addition, it's capable of dual-language, computer-aided instruction and of serving as a sound effects library or an automated radio station programming tool.

Digitally Related

The CES featured plenty of other CD-related products. For example, countless speaker manufacturers boasted new models designed specifically for the digital sound. And there was no shortage of CD cleaning devices or CD storage products.

Toshiba announced a 20-inch digital TV set, the CZ-2094, retailing for \$1199. Toshiba's LSI technology led to the development of A/D converters that digitize the incoming signal before any tuning or signal processing takes place. This provides extra features, such as freeze-frame and better picture quality.

The digital circuitry in the CZ-2094 allows a picture-within-a-picture capability when used with a second source. This means you can preview or monitor a second channel (so you can catch two baseball games at once), or keep an eye on a baby or on your front door.



Computer Systems Management combined a Kyocera DA-01 and an Apple II computer system to form "the world's first intelligent CD player."



There was no shortage of new CD players at the CES. Luxman announced its DX-103, which retails for \$999.95 and features 16-program memory and remote control capability.



Now you can literally "watch a little TV." Epson and Seiko announced hand-sized color sets with 2½-inch screens. Epson's Elf sells for \$500; Seiko's TFT is \$550.

Videodiscs and Other Attractions

Video laserdiscs also attracted their share of attention. Pioneer, for example, introduced its first videodisc jukebox. The player, which stacks up to 60 8-inch laser videodiscs, also includes a 25-inch color monitor, an amplifier, and two speakers.

With a maximum playing time of up to 40 minutes per disc (including both sides), it's capable of playing 2400 minutes of music, or 600 music videos. The video jukebox is expected to be available later this year.

Non-CD-related CES showstoppers included the following:

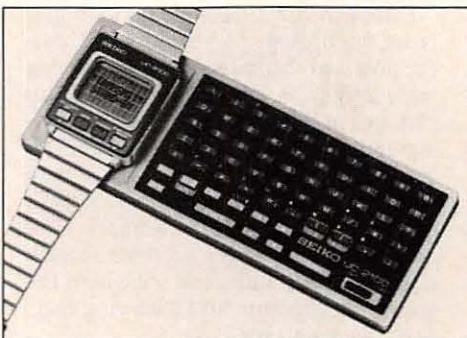
- Miniature color television. Epson announced the Elf, a miniature color TV with a 2-inch (diagonal) screen. The Elf, which produces a picture with a wafer-thin, color CD display panel, measures 6.3 inches W by 3.15 H by 1.22 D; it weighs 1.1 pounds and carries a suggested retail price of \$500.

The Elf comes with a 27-inch antenna, a mini-earphone set, a hand strap, and a carrying case. It receives all VHF and UHF channels and has controls for brightness, color, and tint.

Seiko announced a similar model, its TFT Pocket Color TV. Like the Elf, it can operate on batteries or ac current. Its suggested retail price is \$550.

- Stereo TV. *Consumer Electronics Show Daily* called stereo TV "the most dramatic development since color TV." Television manufacturers seemed to agree, exhibiting more than 50 stereo TV models, along with plenty of add-on stereo decoders. Quasar presented a 26-inch Dyna-Tech table model that will be available in late fall.

- Seiko's RC-1000 Wrist Terminal.



No, you don't wear the computer on your wrist. It's part of the Seiko RC-1000 and, with the wrist watch, serves as an alarm clock, schedule maker, and appointment calendar.

The RC-1000 allows you to enter data directly from your personal computer. The system consists of the wrist module, a pocket keyboard, and a controller. The wrist module includes its own CPU, a 2000-character RAM programmable memory, and a liquid crystal display (LCD).

The RC-1000 is designed to serve as an alarm clock as well as a "memo pad" for keeping track of phone numbers, flight schedules, or appointments. It can memorize 80 items up to a year in advance.

The RC-1000, which retails for \$340, even tells the time and date.

- Cellular mobile telephones. Cellular phones still are retailing for \$2000 to \$3000, but 100,000 or 200,000 units will be in vehicles in more than two dozen metropolitan areas this year, P.M. Scanlon of AT&T Consumer Products estimated.

The Audiovox CMT-1000 was one of

the countless cellular phones announced at CES. It features hands-free electronic scratch pad memory, electronic answering recorder and call forwarding, and duplex hands-free operation by headset. It's priced at \$3000.

- Electronic Tuners. Seiko introduced a quartz chromatic tuner, the ST361, that fine-tunes virtually all musical instruments. The ST361 includes a built-in microphone, speaker, octave select dial, and scale select dial and is capable of generating 72 tones over range from C₂ to B₇.

Seiko also announced two quartz guitar tuners, the ST366 and ST368.

- Hero Jr. Robot. For those who want a preprogrammed companion, Heath's new Hero Jr. stands 19 inches tall, weighs 21.4 pounds, and costs around \$1000. Heath claims that Hero Jr. can sing songs, recite poetry, speak English and "Robish" (its native tongue), wake you up in the morning, guard your home, and play games.

Hero Jr. roams around on three wheels, can carry up to 10 pounds, and is equipped with a 17-key keypad that permits you to modify its personality or initiate a special task. No programming skills are necessary to operate Hero Jr.



Heath's Hero Jr. (\$1000) "works" as an alarm clock, guard robot, and narrator of poetry.

An Audio Irony

Despite these attractive "distractors," the CD still managed to steal the show. A representative from another audio magazine told us, "Digital's dead... I've been to Japan, and the factories have stopped producing," but the prevalence of CDs and CD players spoke for itself. ☐

(The October issue of Digital Audio will include more news and photos from CES.)

Digital Audio Made Easy

by Robert Swartzendruber

Digital audio is a radical departure from 115 years of sound recording history. The use of lasers to reproduce digitally encoded music constitutes a major technological leap, not just another step-by-step refinement of existing methods.

To grasp the significance of digital audio, one needs to understand the underlying principles that make it work.

Playback

Until the late 1960s, all audio amplifying, recording, playback, and transmission was accomplished using analog techniques. In analog processing, an "image" of the music is created by varying some physical property of the recording medium. This image is then converted to an electrical signal, amplified, and fed to a speaker. The most common images used for recording are curves, hills, and valleys in the groove on a record, and a varying magnetic field on tape.

The magnetic signal on a cassette tape varies in response to the sound it is recording. When the magnetic field is stronger, a bigger signal is sent to the audio amplifier and the speakers are driven harder, producing a louder sound. Smaller magnetic fields represent quieter sounds.

It is interesting to note that magnetic tape always has some residual magnetic field, and it's impossible to accurately record the periods of silence that are frequent in classical music.

Just as the cone in a speaker must reverse direction, moving in and out to generate sound, the direction of the magnetic field on a tape reverses polarity to record sound. A compass needle has north and south ends with magnetic fields of opposite polarity. The magnetic field on a tape must change from north to south 1000 times a second to record

a 1000 Hz tone. Recording higher frequency tones requires faster and faster reversal of the magnetic field.

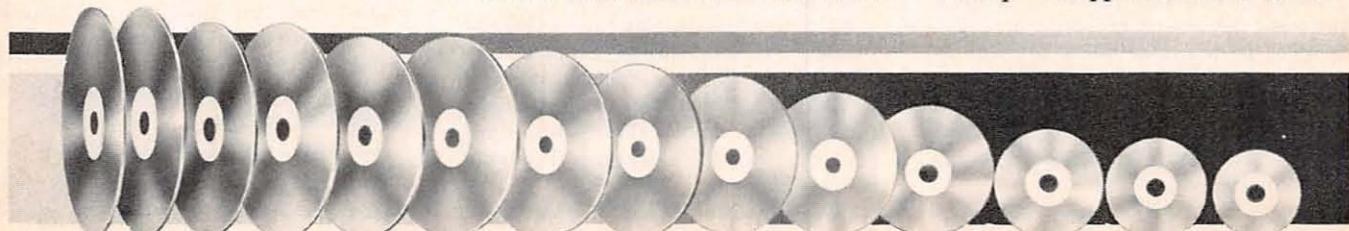
Any extra magnetic signals added by careless handling or by recording heads will be heard as noise. Extra voltages added by the playback heads and system components emerge as noise.

In records, sound is recorded by using larger or smaller hills and curves to control amplitude. The needle reverses direction as it goes from side to side, hilltop to valley. The number of hills, valleys, and curves controls the frequency of the sound being produced. Dust and scratches on an LP record fill the valleys and distort the sound. Because it's impossible to have a perfectly smooth groove in a record, it's again impossible to represent silence.

Tapes and records both employ analog techniques, with some physical properties of the recording medium being analogous to the sound being recorded. Because the physical properties of any medium can be changed by handling, temperature, and even time, an analog recording medium will always add noise.

By the mid-1960s, the performance of audio amplifiers had improved with the use of transistors. The recording medium itself was now the limiting factor in the overall performance of a stereo system. Better tape materials, new head designs, direct cutting of master records, metal mastering techniques, and other analog methods were providing some improvements, but a totally new approach was needed.

Robert Swartzendruber is a Systems Engineer in the Electro-Optics Division of Texas Instruments' Military Equipment Group. He is involved with the development of night vision systems. Previously, he helped to develop digital phone systems for Collins Radio and spent four years working on automatic teller machines for banks. Among his hobbies are ham radio, photography, computers, and, of course, high fidelity audio.



Digital Development

Suppose a system that recorded sound in some fundamentally new way were designed. And what if its recording medium could be soiled, scratched, drenched, and mutilated while accurately conveying the sound and without adding noise? To a degree, such a system already exists—digital audio.

Let's conduct a short experiment. With a piece of paper handy, put on your favorite record or tape. While the music is playing, make a mark on the paper once every second to denote whether the music is "quiet" or "loud."

You have just "recorded" the song digitally. You've crudely "digitized" the music by sampling it at regular time intervals and recording its value at each sampling.

Admittedly, there's a real problem with fidelity here, but let's ignore that for the moment. You can copy your "recording" easily and accurately. A hundred photostatic copies later, you can still read precisely what you recorded—no extra louder, no missing quiet, and no induced noise. You can spill coffee on your paper recording and probably not destroy the information. You can call a friend, read it to him over the phone, and his copy can be as accurate and complete in every detail as yours. As long as the paper remains readable, no noise is included by the recording medium.

Get Bach (To Where You Once Belonged)

Well, big deal. It's gonna be hard to tell Bach from the Beatles with this recording system. But before you give up faith, try this: Assign numbers to the "loudness" of the sound. Use zero for no sound and 255 for the loudest sound your system can produce accurately. Now, listen closely, and divide the volume range into 255 equal levels. Write down the number that most accurately represents the volume; do that 8000 times a second. This process is called quantizing.

You can't write that fast or hear that well? Neither can I. But the whiz kids in Silicon Valley have built integrated circuits that can. How good is the resulting sound? As good as the audio quality of the last long-distance telephone call you made in the United States. Virtually all such calls now are handled with digital audio, using 255 levels and 8000 numbers per second—and you probably didn't even notice.

The process of digitizing audio does

introduce errors, and therefore noise. The human ear is far more sensitive than the telephone company's digital transmission system. For fidelity that matches the abilities of the human ear, more than 14,000 loudness levels are required.

A second digitizing error can result from not sampling often enough. If the sound is reversing polarity faster than it is being sampled, the sampling will

not reflect the polarity reversals. More noise.

If the difference between loudness levels is made smaller than most human ears can sense, and if the audio is sampled often enough to accurately reproduce the highest frequency sound generally discernible, then little or no noticeable noise will be added to the system by digitizing.

The important word here is "notice-

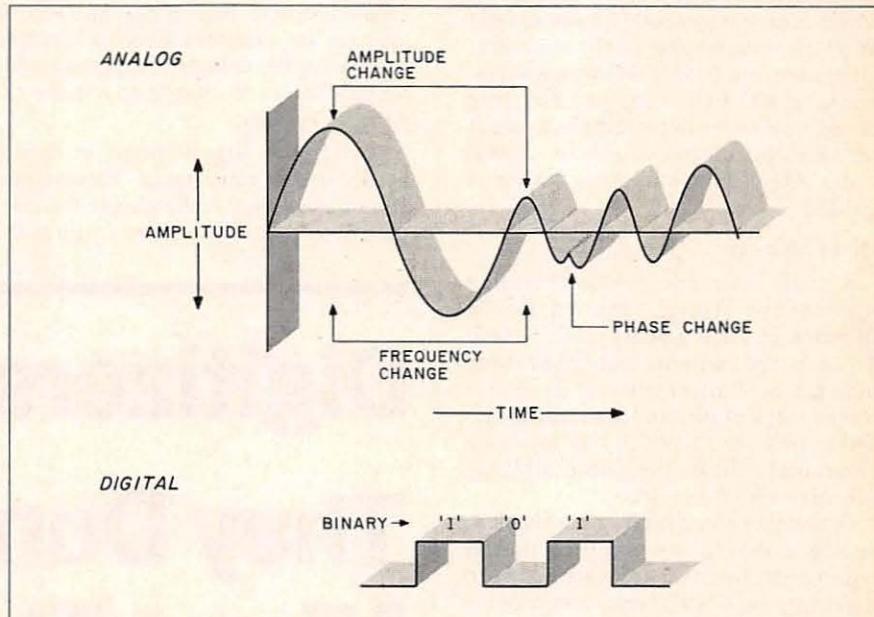


Fig. 1. An analog signal has continuous variations in intensity—it is always in the process of changing its values. But a digital signal is either at maximum value or at zero.

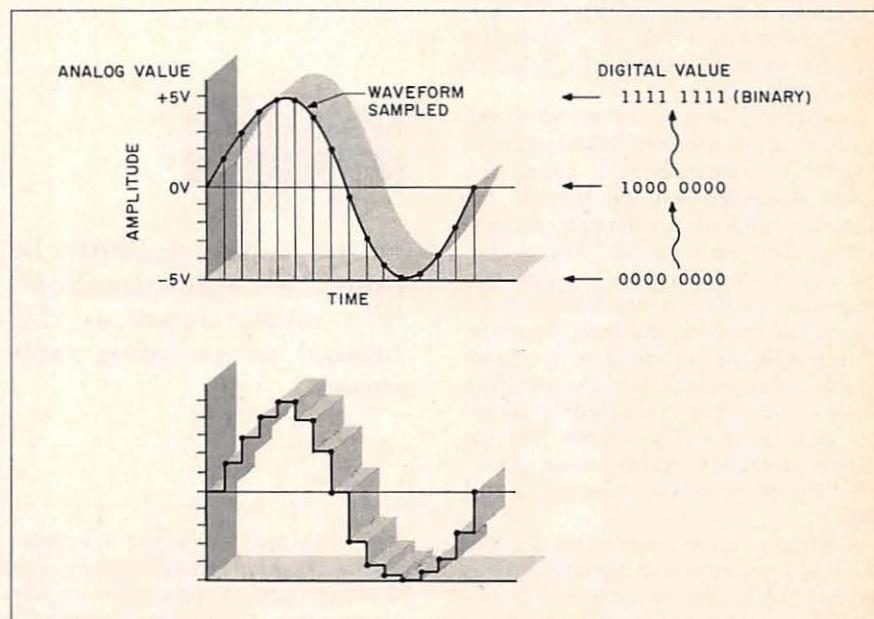


Fig. 2. Each sample "freezes" the sound like an individual frame of a motion picture film. When played back, the samples give the illusion of a continuous waveform, just as the series of stills in a movie gives the illusion of motion.

able." Any system, analog or digital, will have noise. However, once the noise level has been reduced below what the human ear can detect in the residual (ambient) room noise, the system will appear to be perfect. Periods of absolute quiet now can be represented in a recording because the ear does not detect what little noise is actually present.

So now we have a machine that can define the numbers with enough speed and accuracy to generate no discernible noise. How do we record the numbers? Computers are good at storing numbers, but a typical 64K computer has only enough memory to record about eight seconds of telephone-quality digital audio. Obviously something bigger is needed.

Hi-Fi Storage

A single laser disc now is providing the massive storage required for 75 minutes of high fidelity music. One 4.7-inch disc contains more than three billion bits of information in its microscopic track of pits and smooth places. These pits are "read" by a tiny laser beam that reflects back onto a highly sensitive photo detector.

Converting recorded numbers back to analog audio signals requires special equipment. Just as there were errors in digitizing audio with pencil and paper—not having enough level options and not sampling often enough—errors occur in recreating analog audio signals from computer-recorded numbers. No matter how many levels are used, the original samples probably lie between two levels.

A digitizer rounds off sound to the nearest whole number. When converting these numbers back to sound, the level generated will be that of the recorded number, not the exact original value. Thus, an error, or noise, is added. The solution is to use a small enough step size so that errors introduce no discernible noise to the listening room.

Although the system is now considerably more complicated than writing "quiet" and "loud" on a piece of paper, the concept is still as simple. The extreme protection against noise generated by the recording medium is still there.

Certainly, noise is added by the conversion from analog to digital and back again, but it can be reduced to any desired level by using smaller steps between numbers. The frequency response of digital recordings is limited only by how many times a second the

audio signal is sampled. Existing technology is capable of producing sound more subtle than the human ear can perceive.

The Digital/Analog Dilemma

If digital audio is so good, why doesn't everyone use it? First of all, it's expensive. The cost of a digital playback system is still high when compared to a quality tape deck or turntable. For most casual listeners, analog tape and record systems are adequate. Existing libraries are reasonably complete, and there's little motivation to change to a more expensive system.

So far, the largest group of digital audio users consists of commercial sound laboratory technicians—the people who prepare master recordings for

tapes, records, and motion picture sound tracks. Although the final product may be an analog record or tape, the use of digital recording in the studio permits editing, mixing, and duplication without adding appreciable noise. In an industry that has always demanded the very best, nothing less than digital audio performance is now acceptable.

Two decades ago, some experts thought stereo recording was a passing fad. It required two amplifiers, two speakers, and a whole new library of tapes and records. Then, as sales increased, prices came down. The general public now demands stereo for all entertainment music.

Digitized music is following a similar path. More and more people are listening to digitally produced music and won't be happy with anything less. □

Digitizers:

They Don't Miss a Thing

by Bob Leopold

Digital Audio can hardly be called "an approximation" of a music signal, as this tutorial on sampling rates shows.

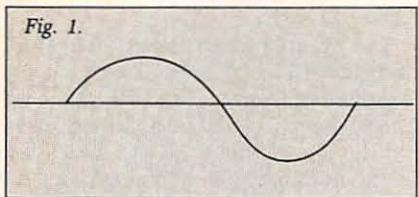
Robert Leopold, who earned a bachelor of science degree in electrical engineering from MIT and a master's degree in business administration from Northwestern University, has worked in design and marketing for several electronics firms. He currently works as a consultant and writer in the electronics field.

How can digital audio accurately recreate an original musical signal if the digitizer only samples the signal every so often? If the signal changes between two adjacent samples, won't the digitizer "miss" what happens?

These questions lead many audiophiles to believe a digital signal is only an approximation of the original musical signal. This just isn't true. Even though we take only periodic samples, the digital system can represent all of the original music.

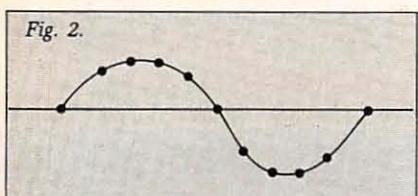
Fig. 1 represents one "cycle" of a particular musical pitch. Think of the ups and downs as the movements of a violin string back and forth. One cycle is the smallest piece of sound in which the or-

ignal pitch is still present. We will allow our digitizer to sample, and therefore digitally represent, this simple music signal.



1 kHz sine wave.

In Fig. 2 we have one cycle of, say, 1 kHz. The dots superimposed on the smooth curve represent the sequence of digital samples. Since each cycle contains 10 digital samples, the sampling rate is 10 times 1 kHz, or 10 kHz. The samples are so close together that the digitizer doesn't "miss" anything that happens.



1 kHz sine wave being sampled at 20 kHz.

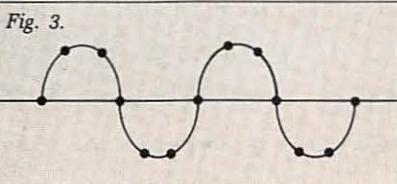
If we had only the dotted samples and played connect-the-dots, we'd end up with the original musical signal. A filter smooths out the tiny staircase irregularities to restore the waveform to its original analog character. So the digitizer is completely able to describe the 1 kHz musical tone.

The digitizer has no problems sampling and describing the 1 kHz pitch in Figures 1 and 2, since there are many samples per cycle. Higher frequencies, however, begin to create problems.

In Fig. 3 we increase the musical pitch to 2 kHz, which means the violin string is moving back and forth twice as fast. We still use the 10 kHz sampling rate. Now there are fewer samples per cycle. The digitizer still manages to see all of the ups and downs and still can describe the 2 kHz pitch accurately. Again, playing connect-the-dots would give us the original signal. Since the digitizer takes fewer samples per cycle, though, we begin to see that still higher pitches could be a problem.

In Fig. 4 we increase the pitch to 5 kHz, but we still use a 10 kHz sampling rate. Now there are only two samples

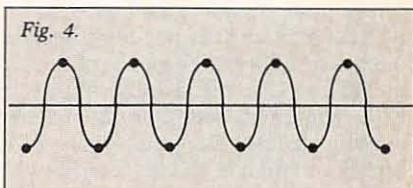
per cycle. The digitizer knows it's sampling a 5 kHz musical tone because



2 kHz sine wave being sampled at 10 kHz.

it sees the ups and downs of each cycle, but that's all it sees. If there were any

small, fast variations between these samples, the digitizer would miss them completely. These fast variations are actually frequencies higher than 5 kHz.



5 kHz sine wave being sampled at 10 kHz.



Wharfedale An Award Winning System

The U.S. Office of Wharfedale, England is proud to announce the recent launch of the Mach Series of high fidelity loudspeakers.

The extraordinary background to this development lies in the rare combination of power, high sensitivity (94 dB SPL 1W/1M) and accurate sound reproduction in practical cabinet sizes. Requiring minimal amplification for room filling sounds (just a few watts will do) the systems are also capable of shattering but clear reproduction with greater power.

Extracts from a U.S. test report of Mach 9 are reprinted with the kind permission of High Fidelity. "What's really impressive, though, is the speaker's sensitivity, which is about 6 dB higher than average. In other words, a typical speaker would require about four times as much power to deliver the same



maximum loudness as the Mach 9..." "That this thoroughly modern Wharfedale is truly "digital-ready" (maybe even disco-ready) is confirmed by its excellent power-handling ability. On our 300-Hz pulse test, it accepted the full 66-volt peak output of the lab's amplifier (equivalent to more than 27½ dBW, or 530 watts, into 8 ohms), for a calculated peak sound pressure level of 122 dB at 1 meter on-axis..."

"That such good sound should come from such a sensitive loudspeaker is a welcome surprise, particularly at a time when we find ourselves more and more often turning down the volume of our amplifiers to avoid clipping the uncompressed peaks on the best Compact Discs. For anyone who loves music—and especially for those who like to play it loud—the Wharfedale Mach 9 deserves a serious listen..."



THE MACH SERIES

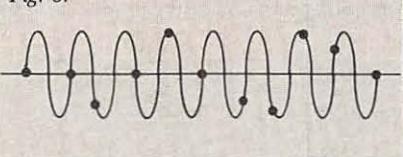
For information on the Mach series and other available Wharfedale speakers, please write or call Wharfedale Loudspeakers, 2224 Fairview, Santa Ana, California 92704 • Tel.: 714-751-5126 or 914-353-1799 (East Coast)

What we have seen is that the digitizer can represent a musical sound completely when it's not higher in pitch than one-half the sampling rate. For a 10 kHz sampling rate, the highest frequency it can sample correctly is 5 kHz. It cannot represent a musical tone higher in frequency (faster) than one-half the sampling rate. This is the essence of the Nyquist Theorem. The Nyquist Frequency is the minimum sampling rate needed to reconstruct the original signal without error, and it is always at least twice the highest frequency you want to sample.

Let's follow through on this thought and show what happens when we try to sample an 8 kHz sound with a sampling rate of 10 kHz. In Fig. 5 the samples are so infrequent, relative to the quickly changing signal, that many of the changes are simply missed by the digitizer. It doesn't see an 8 kHz signal; it's missing much of what's going on.

Now, connect-the-dots can't give us back the original signal. Actually, during playback, the digitizer is fooled into

Fig. 5.



8 kHz sine wave being sampled at 10 kHz.

recreating a musical signal of $10 \text{ kHz} - 8 \text{ kHz} = 2 \text{ kHz}$.

This generates a type of distortion that's non-musical and highly annoying. When a false musical tone is recreated, along with the original one, the false signal is known as an "alias." Once an alias is generated, it gets mixed in with the rest of the signal, and can't be filtered out. After all, how would a filter know if the 2 kHz tone was an alias or if the original music really contained a 2 kHz tone?

Digital designers know all of this, of course, and there is a solution. Naturally, if you make the sampling rate

faster, you could reduce aliasing; but how fast must you go to eliminate it? Designers of audio equipment—even analog gear—recognize that most humans cannot perceive frequencies above 20 kHz.

In FM, only frequencies between 50 kHz and 15 kHz are transmitted. Analog discs and tapes extend the range, but rarely approach a 20 Hz to 20 kHz bandwidth. By having a 20 Hz to 20 kHz bandwidth, a digital circuit exceeds the limits of normal human hearing.

A digital sampler operating at 40 kHz must block out all frequencies above 20 kHz to avoid aliasing. It does the sampling after this filtering, and in theory, can use a 40 kHz sampling rate.

Using a 40 kHz sampling rate for a 20 kHz musical signal is cutting it close. To allow a little margin for error, the engineers really use a 44.1 kHz sampling rate. This elegant scheme allows digital audio to recreate the audible frequency spectrum of music completely even though it only samples the music "every so often." □

Music from: Star Wars • The Empire Strikes Back
• Return of the Jedi • Superman • Raiders of the Lost Ark
Star Trek • Close Encounters of the Third Kind • E.T.



STAR TRACKS

Erich Kunzel
Cincinnati Pops Orchestra
with special Synthesizer Introduction & Closing

CD-80094

TELARC CD's



"...the highest-fidelity sound any music lover can purchase..."
— Rich Warren, *Chicago Magazine*

CHALLENGE: Star Tracks is out of this world — Watch out!
PREMIERES: New Maestro Dohnányi and The Cleveland Orchestra

70 MINUTES: Brahms' powerful vocal expression on one CD

BOLD & BRASSY: Fanfares, Marches and British Band Classics

PURE DIGITAL! All Telarc Compact Discs are produced exclusively from Digital masters made during the recording sessions.



CD-80094



CD-80091



CD-80092



CD-80090

COMPACT
DISC
DIGITAL AUDIO

New ADS speakers revealed.

© 1983 ADS INC.



ADS

The new L780 is one of seven new ADS speakers available in black or walnut finish. You'll recognize it by the new angled corner and distinctive deep-drawn metal grille.

The other day one of our engineers made an interesting observation.

He was trying to illustrate how much better the new ADS speakers sound.

"Think of the speaker as a camera lens," he said. "What we've done is improve resolution, extend depth of field, magnify detail, produce a finer image."

Not a bad analogy we thought, and asked him to go on.

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Interview: Silverstein on Center Stage

"Digital audio is the first really substantial change in recording quality I have heard in my career."

by John Marks

On the concert stage, Joseph Silverstein, noted violinist, concertmaster, and assistant conductor of the Boston Symphony Orchestra, is an unpretentious performer. His stage persona avoids the popular showmanship of some better-known musicians.

Offstage, Silverstein is a soft-spoken but articulate man who has earned his reputation on the merits of superior musicianship. As proof of this, Telarc, a recording company with the clout to sign any musician, chose Silverstein to record Vivaldi's *The Four Seasons* on Compact Disc (Telarc 80070). And to no one's surprise, it has received universal acclaim.

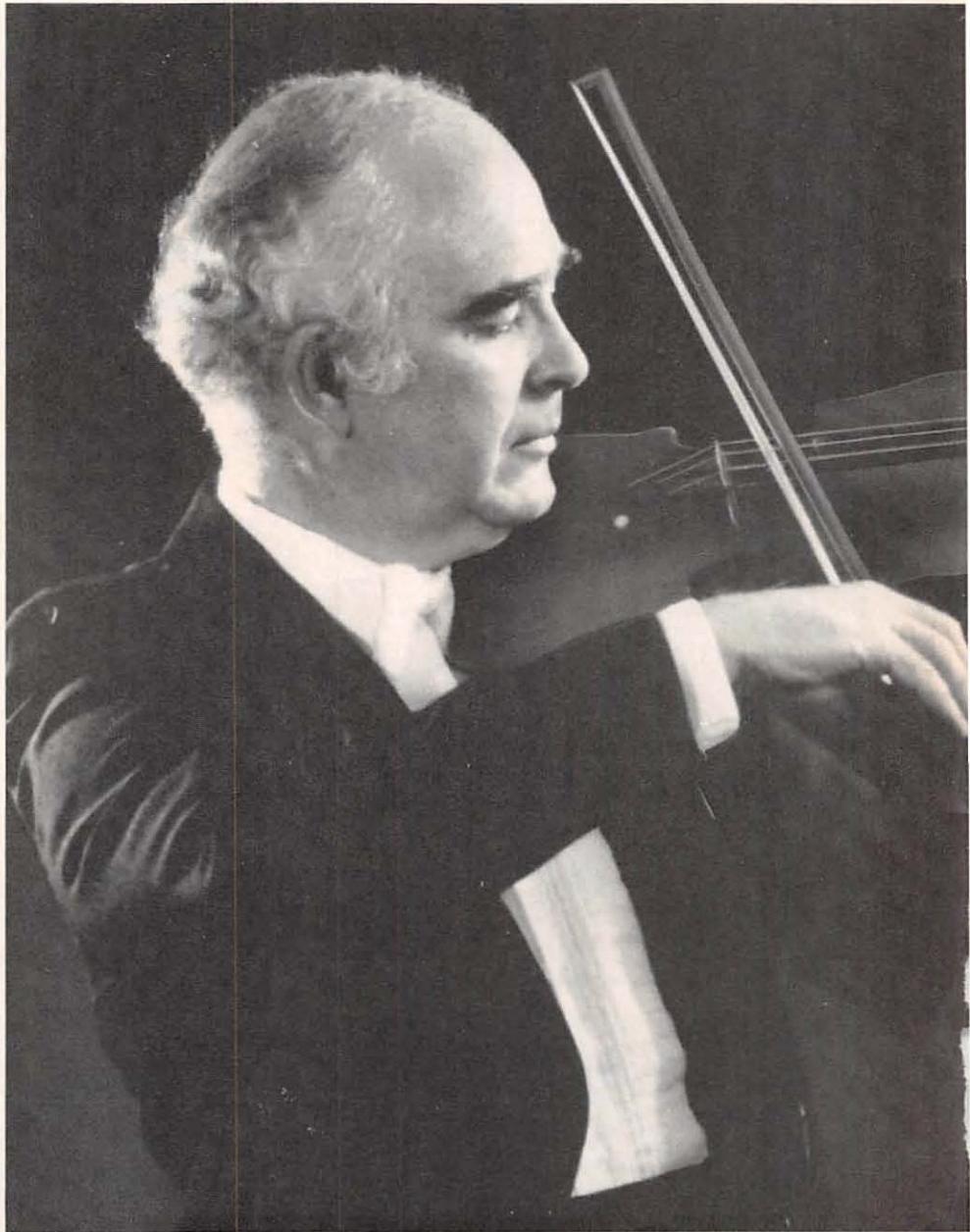
In September Silverstein leaves the Boston Symphony Orchestra and assumes full-time duty as music director of the Utah Symphony.

He joined the Boston Symphony in 1955 at age 23 and was appointed concertmaster in 1961. He took on conducting duties in 1967. Besides appearing regularly as a soloist with the Boston Symphony, Silverstein has played with the orchestras of Denver, Detroit, Los Angeles, New York, San Francisco, Indianapolis, Milwaukee, Philadelphia, and Rochester, NY, in this country and Geneva, Jerusalem, and Brussels abroad.

Silverstein graciously interrupted his busy schedule to give *Digital Audio* an insight into his work and his perspectives on digital recording.

Q: What is the current state of affairs in classical music?

A: In some ways, it's so much better than ever before that we have not come to terms with it. The level of competence of so many orchestras is so high that we have not yet begun to adjust our artistic goals to the capability that ex-





ists; they just play so bloody well out there.

New York Times music critic Harold Schonberg, quite a few years ago, made a list of "the 50 pieces" you always heard orchestras play. Well, "the 50 pieces" are no more. The repertory has broadened enormously. It's more like 15 Mozart symphonies; you used to hear three, perhaps four of them. Now you hear any of 20 Haydn symphonies.

Just last year in Boston we gave our first-ever performance of Elgar's *Dream of Gerontius*. Only recently have you begun to hear the Elgar *Cello Concerto*, the *Violin Concerto*, the two symphonies—and this is only one composer. Sibelius is another example. We're hearing so much more.

Q: And audiences?

A: Audiences have become more selective and more sophisticated in what they will listen to, and in what they expect to hear. And at the same time, the audiences are becoming more involved, more demonstrative, more excited—more so than I remember over the past 30 years.

Also, when you're speaking of classical music, you must realize that there's no such thing as "the boondocks" out there anymore. National Public Radio can be heard all over the country. In Salt Lake City there are three full-time classical music radio stations. People can react to music they hear on the basis of much more experience.

Q: What is your opinion about digital audio?

A: It is very, very important. Digital audio is the first really substantial change in recording quality I have heard in my career. It really makes a difference. The other improvements were only incremental; this is something else.

And it is convenient. I remember the racks of analog tape equipment that had to be trucked around. The engineer arrived for our (Utah Symphony Orchestra's) recording of the Mendelssohn *Violin Concerto* in Salt Lake City with everything in one briefcase. And the sound from those sessions is the best I have ever heard. The recorded sound matches the sound I perceive while playing.

Q: So can we look for this Mendelssohn concerto, with the Utah Symphony, on Compact Disc?

A: Yes. I played and conducted it for the Pro Arte label.

Q: What was your first experience with digital recording?

A: You will have to check me on this, but I believe it was with Frederica von Stade.

Q: Ravel's Sheherazade?

A: Yes. And then there was *Ein Heldenleben* (for Philips). Of course, in 1981, with the Telarc *Four Seasons*, I was obviously much more involved in the whole process.

Q: Are there any differences in performance, or editing, or recording, while making a digital master?

A: The definition is so critical. A small blemish normally lost in the broad sweep of a live performance will stand out in a digital recording. You are getting so much more information.

Q: Are audiences' expectations being raised by edited performances?

A: I don't think so. We try not to edit too much. Heifetz never edited; he did whole movements. In the Chamber Players' recording of the Brahms b minor *Trio*, there's only one splice.



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Q: Is there any unnatural emphasis placed on the soloist in a recording?

A: Well, you'll never hear the same balance between soloist and orchestra in a recording as you would at a live performance, and there's a very good reason. A live performance has something a recording does not: the visual aspect.

The audience at a live performance can see the soloist and listen selectively. To a degree, emphasis is necessary in a recording because you can't see the soloist. It is here that the producer is very important. It can be overdone and frequently has been.

Q: How did your recording of The Four Seasons come about?

A: I really don't know, exactly. The people from Telarc were at Tanglewood, heard a performance, and asked me to record it. I was thrilled and delighted.

Q: What distinguishes your recording from the vast number available?

A: It's the only recording with modern instruments that uses such a small orchestra. We also use extensive ornamentation—trills, grace notes, turns, and so forth. The only other comparably ornamented recording is Simon Stadage's, which uses original or Baroque-style instruments. Stylistically speaking, the Telarc recording, while using modern instruments, approaches performance practices, tempi, and articulation that are more natural to original instruments.

Q: What are the differences between Baroque and modern violins?

A: The modern violin uses metal-wrapped strings, except for the highest string, the E, which is all metal. Because of these metal-wrapped strings—and the angle of the neck—the string tension is greater. The modern fingerboard is longer, encompassing more notes, and the bridge has more curvature, allowing greater bow pressure.

The modern sound is more penetrating, with greater dynamic range and a greater variety of tone color. The original instruments (or modern copies of them) use gut strings and a flatter bridge to try to recreate the sound of the period when the piece was written.

Q: Why did you choose to use modern instruments?

A: It's possible, using modern instruments, to achieve the tempi and articulation of original instruments with-

out sacrificing the dynamic expression and tonal possibilities of the modern ones.

Q: Why did you choose the Wellesley College chapel as a recording site?

A: The people from Telarc and I went from recording site to recording site in the Boston area, and I played for them in each one. Once Houghton Chapel was chosen, I played in different parts of it to sound out the room, and they chose the exact spot for the recording setup.

"Classical music is the happiest manifestation and accomplishment of Western Civilization."

Q: What kind of hall is it?

A: It's made of wood and stone. It has a nice intimacy of sound and the kind of warmth associated with the performance spaces of the Baroque period.

Q: Did you have a particular recording setup?

A: No, our usual. We play fairly close together and try to get enough room ambience.

Q: Did you listen to the takes as you went along?

A: Yes, pretty much so. It went quickly; we did it all in one day.

Q: Do you have a favorite microphone?

A: No, not really.

Q: Have you used the PZM-type microphone?

A: Only experimentally. When I was recording the (Samuel) Barber Portraits (for Nonesuch), we used those along with a suspended regular microphone to get more room sound, but I don't think that's what was finally used.

Q: Do you find The Seasons fun to play?

A: Oh, sure. Especially when you get to choose your ornamentation. Now, in a live performance you can really ornament almost everything, whatever strikes you, and it can sound inspired.

But a recording is to be heard over and over. We wanted ornamentation that people could live with. I think we chose a good balance, a natural outgrowth of the music.

Q: Why is Baroque music so popular with listeners who are new to classical music?

A: There are a couple of reasons. The two elements that are most accessible in music are rhythm and harmony. The subtle use of tonality and structure, which are the hallmarks of the later Classical and Romantic styles, are much more elusive for the new listener.

In Baroque music you have motoric rhythm and harmonic event. These are things people can react to on first hearing.

Q: For listeners just starting out in classical music, what do you recommend they acquire and listen to?

A: I think they should be familiar with something from each of the four main style periods: Baroque, Classical, Romantic, and Modern. From the Baroque period, I would recommend *The Four Seasons* or Bach's *Brandenburg Concertos*. From the Classical period, a Mozart piano concerto. For a Romantic work, a Brahms symphony, and, from the Modern period, Bartok's *Concerto for Orchestra*.

The listener can decide—but it's really not so much a question of periods and dates as it is a question of style.

Q: And I'd just like to point out that all the works just mentioned are available in excellent performances on Compact Disc.

If you had to single out one musical encounter, experience, or performance in your life, what would it be?

A: That's a very, very tough question. Of course, it's the childhood experiences that are the polestars by which adult life is judged. I'd have to say it would be the first time I heard Heifetz in recital and the first time I heard the Budapest Quartet. Of course, I've been listening to records since the age of three, but that's another story.

Q: What is the future of classical music?

A: What is the future of civilization? Playing music is the most civilized thing anyone can do. Classical music is the happiest manifestation and accomplishment of Western Civilization. □

John Marks writes a regular column, "Classical ReMarks," for Digital Audio.

For Newcomers Only:

How to Buy Your First CD Player

The digital bug has bitten you. After listening to several Compact Discs, regular records sound anemic. You're ready, now, for the full CD treatment.

But the digital technology has hatched a myriad of new terms and specifications. As a first-time digital buyer, a little skeptical of yet another "innovation," you probably have many questions. You wonder if your system can cope with the CD's demands.

A Compatible Component

First, let's dispel the myth that you must discard any or all of your existing components when you add a CD player. Your CD player will complement your sound system, since it needs your amplifier and speakers (or headphones).

If you like the sound of your system, you'll love it when you hook up a CD player. Laser optical discs have many advantages over traditional, analog media—no scratches, no ticks, no pops, no surface noise. Digital recording offers still more advantages—cleaner sound, greater dynamic range, better imaging, and wider frequency response. The Compact Disc system is the closest thing to flawless sound you can hear in your home today.

Of course, the quantum leap in sound quality might stimulate you to look for better speakers or a more powerful amp, but they aren't absolutely necessary.

Plug It In, Turn It On

A CD player is the easiest component to connect to your system. Simply plug it into an AUXiliary (or spare Tape Monitor) input on your receiver (or preamp or integrated amp), plug in the power cord, insert a disc, push Play, and enjoy the music. (Most CD players have transit screws to protect the mechanism during shipping, just like analog turn-

tables; so remove these before connecting the player to your system.)

Some of the new amplifiers have a special "Digital Disc" input, but that's nothing more than another AUX input. If you have a "super system," by all means use high-quality connecting cables.

You needn't worry about matching the resistive and capacitive loads with your phono cartridge, or about choosing a proper headamp for your moving coil cartridge. The player has no arms to balance, no counterweights, no anti-skating adjustments, and doesn't have to be placed on a perfectly level surface.

The controls on a CD player are similar to those on a cassette deck, and you'll wish your old turntable had them. Start and Stop are nearly instantaneous. Fast Forward and Reverse let you find a particular place on the disc, and many players let you hear the (slightly garbled) music as the laser skips across the tracks.

Want to play Track Five? Just push button five, then push Play. No longer do you have to find the cut, cautiously place the needle in just the right place, and lower the arm without damaging the record. The CD player's microprocessor takes care of all that for you, automatically.

They Don't All Sound Alike

The second myth to dispel is that all CD players sound alike. The differences aren't as obvious as those among phono cartridges, but more like the differences among cassette decks. When you go shopping, take the trouble to listen to several brands and models, just as if you were shopping for a new tuner or cassette deck.

Listen for the tonal quality. The highs should be clean and clear; the bass should be full and powerful; the mid-range (human voice) should sound nat-

The new Compact Disc Players feature low distortion, no rumble and virtually no maintenance. The audio quality is amazing!



ural and almost like live music. Check for depth and imaging. Can you locate performers on the stereo stage between the speakers? Do some of them seem to be at the front and others at the rear? The motor should be inaudible, because you will be listening to unusually quiet sounds on many of your CDs.

Sampling rates and filters are an area where you'll find some differences. As you probably know already, the CD system operates at a sampling rate of 44.1 kHz. Many manufacturers are promoting sampling rates of 88.2 kHz or even 176.4 kHz. These doubled and quad-

rupled sampling rates aid in the error correction process.

A side benefit is that a less complex filter can be used to block out the higher sampling frequency. Such a filter is less expensive and doesn't cause the extreme phase shift of the more common anti-aliasing filters. Whether this filter is analog or digital makes a difference, too. The digital types have less phase shift, and the stereo image has more depth of field.

Read All About It

Do your reading ahead of time. Find out which players have the features, capabilities, performance, price, and styling you prefer. Some players allow you to select and program a limited number of tracks; others permit up to 99.

Finding a particular section on a disc is easy with almost any CD player. Deciding which type of search controls you want isn't as simple. Different units search by time or by track, audibly or inaudibly, and some will even play the first five seconds of each track until you find something you like. A similar variety of choices is available for Fast-Forward and Reverse functions.

Indexing (the marking of subsections within a longer piece of music) is becoming more common on Compact Discs, so many players can search by index numbers. Many classical discs are programmed to begin a long selection at specific movements.

Then there are the repeat functions. Entire discs, single tracks, or subsections can be repeated easily. An A-B Repeat will permit you to mark any section and replay it. An "Auto Pause" feature can be activated to stop play after each selection, a useful extra for home taping.

For many people, remote control is an accessory that pays for itself in convenience. All of the available remotes are wireless (infrared), but they vary in flexibility. What's important to you depends on how you want to use the player.

Consider that elusive factor called "quality." Look carefully at the unit. In well-constructed equipment, the pieces are smoothly joined. The controls are clearly labelled, have a solid feel, and are firmly anchored to the unit. Disc loading and unloading are easy and convenient, and the drawer opens smoothly and quickly. The player should have safeguards against misloading the disc and crunching it in the drawer.

You'd Better Shop Around

When buying any audio component,

look for a dealer who offers good service, answers questions, and provides informative demonstrations.

Few hi-fi shops are ideal places to listen to quiet sounds. Most salespeople will turn up the volume to impress you; other demonstrations and conversations in the store will intrude on your session; heating and air conditioning units may mask the quiet passages. If things get out of hand, try a pair of headphones, or return at a less busy time of day.

The Rainbow Connection

During the demo, notice that the salesperson is willing to open up new disc cases, and even let you touch them. By contrast, when was the last time a hi-fi salesperson opened a factory-sealed, direct-cut LP and actually permitted you (groan, shudder) to touch it?

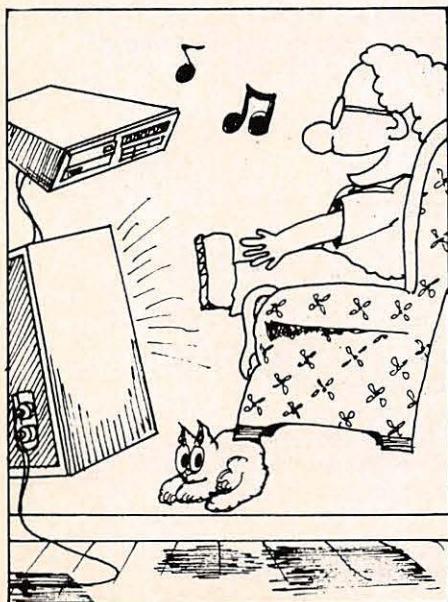
The 4 1/4-inch disc fits the human hand like a glove, which is no accident. That particular size represents a calculated blend of playing time, ease of handling, and minimal storage space on your shelf.

Your CD player will complement your sound system, since it needs your amplifier and speakers (or headphones).

The label side of the disc is for you to read, but the laser beam reads the other side, where all the data bits are stored as tiny pits on a reflective surface. The transparent coating protects the data and can sustain a fair amount of abuse before the error correction codes are unable to restore missing bits.

Fingerprints and dust aren't a problem, because they don't affect the actual information and can be wiped off. But deep scratches, clogged with dirt, can cause read errors when the laser tries to penetrate to the data layer. So you should handle a CD with a moderate amount of care.

Notice the characteristic rainbow effect as you hold a disc up to the light. The extremely close circular tracks on a CD act as a diffraction grating and break up ordinary light into its spectral components—a rainbow.



Pop Goes the Disc

During the demo, listen to a variety of music—instrumental and vocal, classical and popular—on a variety of CD players. Also, be sure to listen to a solo piano recording, because this is one of the toughest tests for an analog LP. Wow and flutter muddy the sound considerably on an LP; on a CD, a solo piano sounds unexpectedly real.

Ask if the demo recording was digitally recorded. If it wasn't, you won't hear all of the CD's capabilities. Although an excellent analog recording sounds even better on CD, it may have a noticeable amount of tape hiss. Remember that the CD isn't responsible—it's just accurately reproducing the flaws of the original. Analog recordings won't reveal the CD's wider dynamic range, so be sure to listen to samples of each type.

In the realm of pop recording, true all-digital CDs are rare. You'll have to be persistent to find one, because most pop musicians haven't learned to use the digital medium; they're still creating for the old analog medium.

Another problem with most pop recordings is that they are mixed for radio play, so they have limited dynamic range. The best advice is to request a CD featuring a folk singer with guitar, and you'll be able to hear some very quiet sounds along with the loud ones.

What you hear when the disc begins is the hook. The normal clues that the music is about to start are gone—no tell-tale, needle-down sound, no subtle tape hiss. The music leaps out of silence. Most people are startled by it, so don't be surprised if you jump a bit, especially if the particular selection starts with a loud, percussive attack.

Oh yes, you won't need to perform the cleaning ritual, or turn the record over, or worry about wearing it out by playing it again. When it's finished, you won't have to jump up and return your valuable disc to its jacket before it gathers dust.

Bug-free Generation

Still not convinced about CD players? Don't be afraid of making a bad choice. There's no need to wait "until they perfect them." The current generation of CD players is virtually bug-free—and ready for the mass market. □

This article was researched and written by the Digital Audio staff.

Is It Live or Is It Digital?

by Steve Birchall

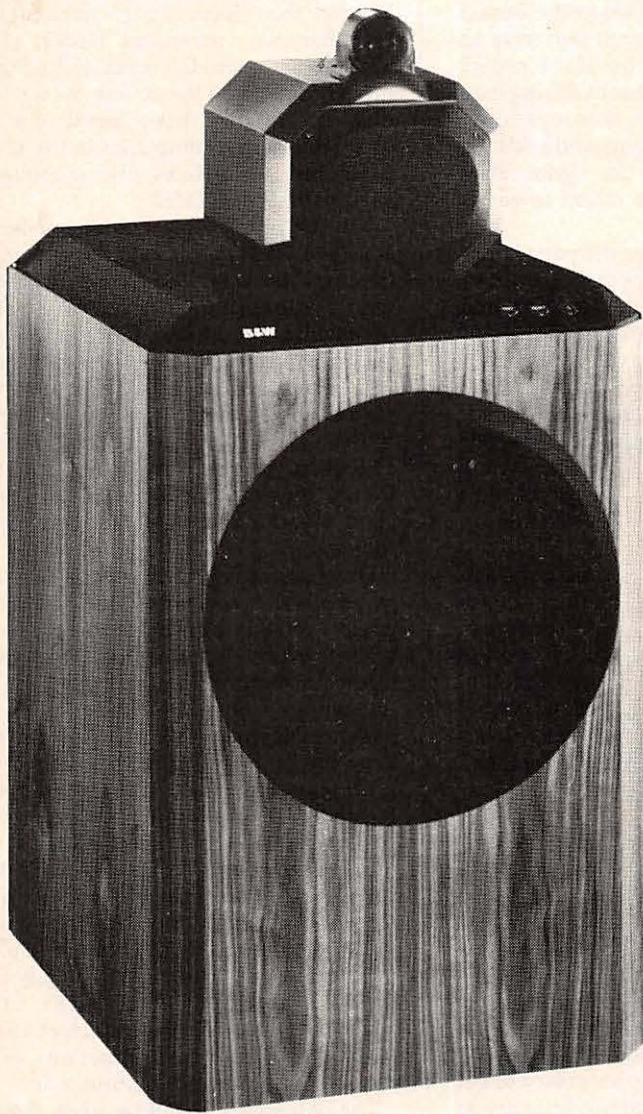
Benefits of the Compact Disc

1. Longer playing time
2. No warp-induced problems
3. Insignificant wow and flutter
4. Rumble non-existent
5. No cartridge and tonearm mistracking
6. Distortion significantly reduced below previous technology
7. Distortion is worst at quietest levels (thus inaudible)
8. Distortion does not increase near center of disc
9. No loss of high frequencies near center of disc
10. Channel separation same at all frequencies
11. No groove pre-echo
12. Residual noise does not obscure ambient information
13. Surface noise (ticks and pops) eliminated
14. Channel separation (90 dB) sharpens stereo image
15. Phase linearity provides spacious stereo image
16. No groove wear from repeated play
17. No groove wear from playback on inferior or misaligned units
18. Same quality at every point on disc (inner tracks same as outer)
19. No cartridge "personality" to compensate for
20. No cartridge misalignment
21. No vertical tracking angle problems
22. No possibility of improper tracking force
23. No anti-skating to adjust
24. No need to clean and de-staticize CD before each playback
25. No stylus to clean
26. Immune to bumps and footsteps
27. Immune to feedback
28. Less sensitive to handling problems (dust and scratches)
29. Extended dynamic range sounds real
30. Frequency response is wider and flatter
31. No coloration from phono preamp equalization errors
32. No phase shift or distortion from phono preamp de-emphasis circuit
33. Can display text and/or still pictures on a video monitor
34. Provides timing information
35. Can be used as data disc for personal computers
36. Sounds good even at low listening levels

Disadvantages of CD

1. Lack of available software ("only" 1400-plus titles)
2. Current cost of discs
3. Current cost of players
4. Inexperience of producers and engineers with CD medium
5. No pop artists currently exploiting CD idiomatically
6. Whets appetite for better speakers and amplifier
7. Smaller graphic art on cover (but see No. 33 above)
8. Liner notes hard to read (small typefaces—but see No. 33 above)
9. No U.S. pressing plant (two in operation by end of year)
10. Difficult to broadcast on FM
11. Difficult to copy onto home cassette tape
12. Too distracting, forces you to listen attentively

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Reader's Guide to the Buyer's Guide

All Compact Disc players sound the same. All specifications are identical—and "perfect." The only differences are in the controls and programming features.

Despite the obvious fallacies behind these statements, such remarks fill the pages of many hi-fi magazines, both underground and above-ground.

Clearly, differences between CD players do exist, and the specs are not identical, and they are not "perfect." If you ask only about frequency response, signal-to-noise (s/n) ratio, wow and flutter, or total harmonic distortion (THD), you'll get boringly perfect numbers. But if you probe a little deeper, you'll find—as we did—that the manufacturers don't even have answers for some of the more interesting questions.

In fairness to manufacturers, we have to acknowledge that standard testing methods for many CD player parameters have not been developed, nor are any test CDs available to the general public. Perhaps the best service *Digital Audio* can render is to ask for better, more comprehensive tests and measurements.

Sheep and Goats

So, what really separates the sheep from the goats? Since the digital parts of the circuit are on standard chips (some companies make their own proprietary chips), the most crucial parts of the circuit are at the analog (output) end.

Of special importance is the anti-aliasing filter. Analog filters introduce small amounts of distortion and extremely large amounts of phase shift, increasing with frequency. Digital filters reduce these problems to insignificant levels, and they are beginning to appear more frequently on CD players.

In either case, the cutoff frequency must be fairly close to the upper limit of the bandwidth, and the rolloff slope must be very steep. For an analog filter, that means an expensive, complex circuit, such as a ninth-, eleventh-, or thirteenth-order Chebyshev type.

The phase shift in some filters actually exceeds 360 degrees. In loudspeaker crossovers, designers usually prefer lower-order filters to avoid the phase shift problems, because phase distortion destroys the imaging capabilities of the speaker. Exactly the same thing happens in a CD player, and the stereo image will not have the spaciousness, nor the precise localization of performers on the stereo stage that the medium can

deliver to your ears. This is one of the most noticeable differences from one CD player to another.

The quality of the electronic parts in the filter is another important factor. Cheap resistors and capacitors with looser tolerances don't sound as good as audio-grade parts. Metal film resistors produce less thermal noise in the circuit, which is an important consideration in a CD player with a 90 dB s/n.

Capacitors store small amounts of electricity and discharge it when a particular threshold is reached. If all of the electricity is released when the capacitor discharges, the circuit performs according to its design, but if the capacitor retains a small amount during each charge/discharge cycle, it rounds off the sharp edges of transients and adds distortion and noise to the signal. Polypropylene capacitors cause fewer of these problems.

Tighter tolerances for the parts (1 percent instead of 10 percent resistors) make the circuit perform as designed, rather than approximating the intention. If a resistor in your player is 10 percent over the average value, and the resistor in the next unit off the production line is 10 percent under, the cutoff frequency or the rolloff slope might be significantly different. Ask questions, look under the cover, and always listen before you buy.

Another phase-related problem stems from the use of one digital-to-analog converter (DAC) to serve both channels. By switching rapidly from left to right channels, one DAC does the work of two. But one channel is 11.5 ms behind the other. The good CD players have a buffer to eliminate this time differential, but many do not.

How to Stump a Manufacturer

As you look through the following buyer's guide, you'll find that most manufacturers were unable to give a specification for phase linearity, even at a nominal 1 kHz. In fact, most were surprised that anyone would want to know. A common response to this (and to several other questions) was that a call to Japan would be necessary to get the information. But phase linearity at all frequencies is an area of real difference—and an area of real competition—among CD players. Frequency response is not, so manufacturers are all too happy to boast of their "perfect" specs in this category.

Channel balance is an interesting parameter, because differences of half a dB can cause a vague cloudiness in the sound; the cloudiness is difficult to attribute to the small difference in level between channels. Most manufacturers weren't prepared to answer this question. Related to it is the question of channel separation. In the digital parts of the circuit, this isn't a problem, but in the analog section, cross talk can, and does, develop.

Incredibly enough, some manufacturers were unwilling to give any specs beyond the "Basic Four" (frequency response, s/n, wow and flutter, and THD). Some couldn't even tell us the power draw from the ac line, which indicates that they have less-than-adequate marketing companies in the U.S. (Can those companies offer adequate support after the sale?)

For the more sophisticated readers, we have attempted to gather information on interfacing the CD player with your preamplifier. Output levels and impedances must match those on the inputs of your preamp, or the signal suffers losses and distortion. If they don't match, choose another player, or use a buffer to match impedance and level. The difference between 2.0 V and 2.5 V can mean the difference between good sound and distorted, overloaded inputs.

One familiar holdover spec from analog does not appear in this buyer's guide, even though every manufacturer, without exception, provides it: wow and flutter. It simply doesn't apply to CD technology, because the rotational speed varies from 200 to 500 rpm to keep the bit stream at a constant rate.

More to the point, the retrieved data is stored in a buffer memory and clocked out by a quartz oscillator.

The programming features are a side benefit of the presence of a microchip. Since the possibilities are built in, why not make use of them? Some people won't need or want to play CDs in scrambled order, or skip tracks, but many people do. When interactive CDs become available, these functions will assume a far more important role.

The best advice to follow when shopping for any audio component is to *listen* to it. After all, beautiful sound is what you want, not impressive numbers on a beautiful brochure. ☐

—S.B.

Buyer's Guide to CD Players

compiled by Jane Holopainen and Ken White

| Brand | Akai | Denon | Denon | Dual | Fisher | Fisher |
|--|--|--|--|--|---|---|
| Model | CD-D1 | DCD-1800 | DN-3000 FE (pro model) | CD 120 | AD 840 | AD 844 |
| Price | \$1000 | \$900 | Not Available | \$899.95 | \$649.95 | \$649.95 |
| Frequency Response | 20 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB |
| Dynamic Range | 90 dB | 95 dB | 90 dB | > 90 dB | > 95 dB | > 95 dB |
| Signal-to-Noise Ratio (weighted, unweighted) | > 90 dB | 96 dB | 100 dB ¹ | > 90 dB | 90 dB | > 90 dB |
| Total Harmonic Distortion (% at 1 kHz) | 0.005% | 0.003% | 0.007% | 0.03% | 0.004% | 0.004% |
| Intermodulation Distortion (% referred to 0 dB) | <0.005% | | | | | |
| Output Filter | Both | Both | Both | Analog | Both | Both |
| Phase Linearity (Angle of Deviation) | | | | | | |
| Channel Separation (at 1 kHz) | 90 dB | 94 dB | 90 dB | > 85 dB | > 90 dB | > 90 dB |
| Channel Balance | | | | | | |
| Max. Output Level | 2 V | 2 V | 1.7 V | 1.4 V | 2 V | 2 V |
| Line Output Level (Fixed, Variable) | 2 V, 0-2 V | | | | | |
| Line Output Load Impedance | | | 600, bal. 50, unbal. | | | |
| Headphone Output Level (8 ohms, V; 600 ohms, V) | No headphone output | | 24 mW (max.)/ 2 ohms | | | |
| Error Correction (Type) | CIRC | | | | CIRC | CIRC |
| Number of Pickup Beams | 1 | 1 | 1 | 1 | 3 | 3 |
| Cueing Time from Pause | 3 seconds | | 4 seconds | 7 seconds approx. | | |
| Max. Search Time | 4 seconds | | | | | |
| Programmable? | Yes | Yes | Yes | Yes | Yes | Yes |
| Max. Track Number Countable | 99 display 24 random | 15 random | | 15 | 99 display 23 sequential | 99 display 23 sequential |
| Remote Control? | No | Available | Available | No | No | No |
| Remote Control Type | N/A | | | N/A | N/A | N/A |
| Indexing? | Yes | Yes | Yes | Yes | No | No |
| Dimensions | 13"-11 ³ / ₄ "·2 ³ / ₄ " | 18"-4 ¹ / ₂ "·14 ¹ / ₂ " | 16 ¹ / ₂ "·31 ¹ / ₂ "·21 ³ / ₄ " | 12 ¹ / ₂ "·5 ³ / ₄ "·9 ¹ / ₄ " | 15 ³ / ₄ "·3 ¹ / ₂ "·11 ³ / ₈ " | 17 ¹ / ₂ "·3 ¹ / ₂ "·11 ³ / ₈ " |
| Weight | 16.3 lbs. | 20.9 lbs. | 88 lbs. | 13 lbs. | 8.8 lbs. | 9.5 lbs. |
| Power Consumption | | 28 W | 90 W | 27 W | 20 W | 20 W |
| Disc Loading (Front, Top, Drawer) | Front | Front drawer | Top | Front swing-out | Front drawer | Front drawer |

| Hitachi | JVC | Kenwood | Kyocera | Kyocera | Luxman | Magnavox |
|---|--|---|--|---|---|--|
| DA-800 | XL-V2 | DP-1100B | DA-01 | DA-910 | DX-103 | FD 1000SL |
| \$1000 | \$750 | \$899 | \$1050 | \$1600 | \$999.95 | \$599 |
| 5 Hz to 20 kHz | 5 Hz to 20 kHz, ±0.5 dB | 2 Hz to 20 kHz, ±0.5 dB | 20 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 20 Hz to 20 kHz, ±0.3 dB |
| > 96 dB | 96 dB | 95 dB | 90 dB | 90 dB | > 90 dB | > 90 dB |
| 95 dB | 100 dB (digital zero) | 95 dB (no frequency) | 90 dB | 95 dB | | > 90 dB |
| < 0.003% | 0.0025% | 0.0015% | 0.005% | 0.005% | < 0.007% | < 0.005% |
| | | | | | | < 0.005% |
| Analog | Digital | Analog (9th-order Chebyshev) | Both | Digital and 3rd-order Bessel filter | | Digital |
| | | | 110° (at 10 kHz) | 80° (at 20 kHz) | | 0.5° |
| 94 dB | 100 dB | 90 dB | 90 dB | | | > 86 dB |
| | | 90 dB | < 0.5 dB | | | < 0.3 dB |
| 2.5 V | 2.2 V | 2 V | 2 V | 5 V/2 V/0.77 V | | 2 V rms, typical |
| | | | 2 V | | 0–5 V, variable | |
| | | 600 ohms | 50 kilohms | 1 kilohm | | 10 kilohms |
| 2.5 V variable | | 31 mW | No headphone output | | | No headphone output |
| CIRC | | CIRC | CIRC | CIRC | | CIRC |
| 3 | 1 | 1 | 1 | 1 | | |
| | | 3 seconds | | | | |
| | | 2 seconds | | 2 seconds approx. | | |
| Yes | Yes | Yes | Yes | Yes | | Yes |
| 99 countable 15 programmable | | 99 countable 16 programmable | 99 countable 24 programmable | 24 (random & sequential) | | 15 random |
| No | No | Included | No | Included | | No |
| N/A | N/A | Infrared | N/A | Infrared | | N/A |
| Yes | | Yes | Yes | Yes | | No |
| 17 ¹ / ₄ "·4 ³ / ₈ "·10 ¹ / ₂ " | 13 ³ / ₈ "·4 ¹ / ₄ "·11" | 17 ¹ / ₄ "·3 ¹ / ₂ "·12 ¹ / ₂ " | 18 ¹ / ₄ "·5 ³ / ₁₆ "·12 ⁵ / ₈ " | 17"·5 ¹ / ₂ "·13" | 16 ¹ / ₂ "·3 ³ / ₈ "·13 ¹ / ₄ " | 12 ¹ / ₂ "·7"·10 ¹ / ₂ " |
| 15.9 lbs. | 14.7 lbs. | 17.2 lbs. | 18.5 lbs. | 21 lbs. | 15 lbs. | 11 lbs. approx. |
| 50 W | | 20 W | 30 W | 33 W | | < 35 W |
| Front drawer | Drawer | Front drawer | Front swing-out | Front drawer | Front | Top |

| Brand | Magnavox | Magnavox | Magnavox | Marantz | Marantz | Micro Seiki |
|--|---|--|---|---|---|--|
| Model | FD 2000SL | FD 2020SL | FD 3030SL | CD 73 | CD 54 | CD-M1 |
| Price | \$699 | \$699 | \$799 | \$999.95 | \$649.95 | \$1100 |
| Frequency Response | 20 Hz to 20 kHz, ±0.3 dB | 20 Hz to 20 kHz, ±0.3 dB | 20 Hz to 20 kHz, ±0.3 dB | 20 Hz to 20 kHz, +0.1, -0.2 dB | 4 Hz to 20 kHz, ±0.1 dB | 20 Hz to 20 kHz, ±0.5 dB |
| Dynamic Range | > 90 dB | > 90 dB | > 90 dB | > 90 dB | 90 dB | > 90 dB |
| Signal-to-Noise Ratio (weighted, unweighted) | > 90 dB | > 90 dB | > 90 dB | > 90 dB | 90 dB | > 90 dB |
| Total Harmonic Distortion (% at 1 kHz) | < 0.005% | < 0.004% | 0.004% | 0.044% (referred to -24 dB) | 0.0025% | 0.005% |
| Intermodulation Distortion (% referred to 0 dB) | < 0.005% | < 86 dB | < 86 dB | 0.007% | | 0.005% |
| Output Filter | Digital | Digital | Digital | Both | Digital | Both |
| Phase Linearity (Angle of Deviation) | 0.5° | ±0.5° | ±0.5° | < 1° | < 1° | |
| Channel Separation (at 1 kHz) | > 86 dB | > 90 dB | > 90 | 90 dB | 90 dB | > 90 dB |
| Channel Balance | < 0.3 dB | < 0.3 dB | < 0.3 dB | | | > 0.5 dB |
| Max. Output Level | 2 V rms | 2 V rms, typical | 2 V rms, typical | 2.12 V | 2 V | 2 V |
| Line Output Level (Fixed, Variable) | | | | | | |
| Line Output Load Impedance | 10 kilohms | 10 kilohms | 10 kilohms | | | 50 kilohms |
| Headphone Output Level (8 ohms, V; 600 ohms, V) | No headphone output | 2 V | No headphone output | | | No headphone output |
| Error Correction (Type) | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC |
| Number of Pickup Beams | | 1 | | 1 | 1 | 1 |
| Cueing Time from Pause | | | | 3 seconds | | |
| Max. Search Time | | | | | | |
| Programmable? | Yes | Yes | Yes | Yes | Yes | Yes |
| Max. Track Number Countable | 15 | 15 | 15 | 15 | 15 display 8 random | 99 display 24 programmable |
| Remote Control | No | Available | No | Available ² | Available | No |
| Remote Control Type | N/A | Infrared | N/A | Infrared | Wireless | N/A |
| Indexing? | No | No | Yes | No | No | Yes |
| Dimensions | 16 ¹ / ₂ "·3 ¹ / ₂ "·11 ³ / ₄ " | 16 ¹ / ₂ "·3 ³ / ₄ "·12" | 16 ¹ / ₂ "·3 ¹ / ₂ "·12 ¹ / ₂ " | 16 ¹ / ₄ "·3 ¹ / ₂ "·11 ³ / ₄ " | 12 ⁵ / ₈ "·3 ¹ / ₂ "·11 ¹ / ₂ " | 18 ¹ / ₄ "·5 ³ / ₁₆ "·12 ⁵ / ₈ " |
| Weight | 13.2 lbs. | 13 lbs. approx. | 17 lbs. approx. | 17.6 lbs. | 16.5 lbs. | 18.5 lbs. |
| Power Consumption | < 40 W | 27 W | 30 W approx. | | | 30 W |
| Disc Loading (Front, Top, Drawer) | Top | Top | Front | Front drawer | Front drawer | Front swing-out |

| Mitsubishi | NAD | NEC | NEC | Onkyo | Pioneer | ReVox |
|--|--|--|---|--|---|--|
| DP-103 | 5200 | CD-803 | CD-705E | DX-3000 | P-D70 | B225 |
| \$650 | \$650 | \$1300 | \$995 | \$999.95 | \$749.45 | \$1150 |
| 5 Hz to 20 kHz, +0.5, -0 dB | 20 Hz to 20 kHz, +0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 2 Hz to 20 kHz , ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 20 Hz to 20 kHz, ±0.5 dB |
| > 90 dB | | > 90 dB | > 90 dB | 95 dB | > 95 dB | |
| 103 dB, 96 dB | 98 dB ⁵ , 94 dB ⁶ | > 90 dB | > 90 dB | 95 dB | > 95 dB | 100 dB, > 96 dB |
| 0.003% ³ , 0.0014% ⁴ | 0.01% | < 0.001% (5 Hz to 20 kHz) | < 0.01% (5 Hz to 20 kHz) | 0.003% | < 0.004% | 0.005% |
| 0.006% | | | Unmeasurable | 0.003% | < 0.004% | 0.003% |
| Analog | Both | Digital | Digital (non-delay) | Both ⁷ | Analog (11th-order low-pass) | |
| | +1 dB from 0 to 80 dB | | | | 133° at 20 kHz, 15° at 10 kHz | < 1° |
| 114 dB | 90 dB | > 70 dB (5 Hz to 20 kHz) | > 70 dB (5 Hz to 20 kHz) | 90 dB | > 90 dB | < 90 dB |
| | | | | | 0 dB, ± 1 dB | 0.1 dB |
| 1.95 V | 2 V | | | | 2 V rms at 1 kHz | 2 V |
| | | 1.5 V, 470 ohms; 0–1.5 V, 2.5 kilohms | 1.5 V, 470 ohms | 2 V rms | 200 mV rms ±20 mV at 1 kHz | 2 V, 0–2 V |
| 50 kilohms | 220 ohms | | | 50 kilohms | 100 kilohms | 10 kilohms min. |
| 0.58 V, 5.6 V | No headphone output | | | 30 mW | 36 mW (32 ohms) | 13 V (35 mW to 600 ohms) |
| CIRC | CIRC | CIRC | CIRC | | CIRC | CIRC |
| 3 | 1 | 1 | 1 | 1 | 3 | 1 |
| | | | | 0.25 seconds | 5 seconds | < 0.6 seconds |
| | | 3 seconds (average) | 3 seconds (average) | 3 seconds | 6 seconds | < 4 seconds |
| No | No | Yes | Yes | Yes | Yes | Yes |
| 99 | 99 | 99 display 15 random | 99 display 15 random | 8 random | 99 countable 10 random | 19 |
| No | No | Included | Included | | Available | Available |
| N/A | N/A | Infrared | Infrared | | Wired | Infrared |
| No | No | Yes | Yes | Yes | Yes | Yes |
| 13 ³ ₄ "·4"·12 ⁵ ₈ " | 16 ¹ ₂ "·3 ¹ ₄ "·13" | 16 ³ ₄ "·5 ³ ₄ "·14" | 16 ⁵ ₁₆ "·4 ³ ₄ "·14 ³ ₁₆ " | 17 ³ ₄ "·4 ¹ ₂ "·15" | 16 ¹ ₂ "·3 ⁷ ₈ "·11 ³ ₄ " | 17 ¹ ₂ "·4 ¹ ₄ "·13" |
| 14.7 lbs. | 13.7 lbs. | 26.4 lbs. | 23.1 lbs. | 21.3 lbs. | 16.9 lbs. | 19.8 lbs. |
| 22 W | 30 W | 58 W | 39 W | 40 W | 38 W | 40 W |
| Front drawer | Drawer | Front vertical | Front drawer | Front drawer | Front drawer | Front drawer |

| Brand | Sansui | Sanyo | Scott | Sears | Sharp | Sherwood |
|--|--|--|---|---|---|---|
| Model | PC-V1000 | CP200 | 939DA | 57 AP 9750C | DX-500(S) | CDP-100 |
| Price | \$1000 | \$649.95 | \$599.95 | \$389.99 | \$649.95 | \$499.95 |
| Frequency Response | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz | 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB |
| Dynamic Range | > 96 dB | > 96 dB | > 95 dB | > 90 dB | 97 dB | > 95 dB |
| Signal-to-Noise Ratio (weighted, unweighted) | > 96 dB | > 96 dB | > 95 dB | > 90 dB | 97 dB ⁸ , 92 dB ⁹ | 95 dB ¹⁰ , 100 dB ¹¹ |
| Total Harmonic Distortion (% at 1 kHz) | < 0.004% | 0.003% | < 0.0015% | 0.003% | 0.003% | 0.0015% |
| Intermodulation Distortion (% referred to 0 dB) | | | | | .0007% | |
| Output Filter | Digital | Digital | Both | | Analog (Chebyshev) | Both ¹² |
| Phase Linearity (Angle of Deviation) | | | | | | |
| Channel Separation (at 1 kHz) | | 92 dB | > 90 dB | > 90 dB | 97dB ⁸ , 92 dB ⁹ | > 90 dB |
| Channel Balance | | | | | 2 dB | |
| Max. Output Level | 2 V | 2 V | 2 V | | | |
| Line Output Level (Fixed, Variable) | | | | | 2.1 V | 2 V |
| Line Output Load Impedance | | 470 ohms | | | 10 kilohms | |
| Headphone Output Level (8 ohms, V; 600 ohms, V) | None | 7.8 mW (8 ohms) | No headphone output | | 48 mW (8 ohms) | No headphone output |
| Error Correction (Type) | CIRC | CIRC | CIRC | | CIRC | CIRC |
| Number of Pickup Beams | 1 | 1 | 3 | | 1 | 3 |
| Cueing Time from Pause | | | | | | < 0.5 second |
| Max. Search Time | | | | | | N/A |
| Programmable? | Yes | Yes | Yes | No | Yes | Yes, sequentially only |
| Max. Track Number Countable | 15 random | 16 random | 99 countable 23 programmable | 16 | 20 | 99 sequential |
| Remote Control? | Available | No | No | No | No | No |
| Remote Control Type | Infrared | N/A | N/A | N/A | N/A | N/A |
| Indexing? | No | No | No | No | No | No |
| Dimensions | 16 ⁵ ₁₆ " .4 ³ ₈ " .11 ¹¹ ₁₆ " | 13" .3 ¹ ₄ " .12 ¹ ₂ " | 17" .3 ¹ ₂ " .11" | 13 ¹ ₄ " .3 ¹ ₂ " .12 ¹ ₂ " | 13" .4 ¹ ₈ " .13 ⁹ ₁₆ " | 13 ³ ₈ " .3 ⁵ ₈ " .11 ³ ₈ " |
| Weight | 15.9 lbs. | 13 lbs., 3 oz. | | 16 lbs. | 18.7 lbs. | 8 lbs. |
| Power Consumption | 50 W | 35 W | 20 W | | 40 W | 20 W |
| Disc Loading (Front, Top, Drawer) | Front drawer | Front drawer | Front drawer | Drawer | Front drawer | Front drawer |

| Sony | Sony | Sony | Sony | Sony | Sony | Sony |
|--|--|--|--|---|--|--|
| CDP-101 | CDP-200 | CDP-400 | CDP-610ES | CDP-701ES | CDP-5000 | CDP-3000 |
| \$900 | \$700 | \$800 | \$850 | \$1500 | \$6500 | Not Available |
| 5 Hz to 20 kHz, ±0.5 dB | 5 Hz to 20 kHz, ±0.5 dB | 20 Hz to 20 kHz, +0.5 dB, -1.0 dB | 20 Hz to 20 kHz, +0.5, -1.0 dB |
| > 90 dB | > 90 dB | > 95 dB | > 95 dB | > 95 dB | > 94 dB | > 94 dB |
| > 90 dB | > 90 dB | > 95 dB | > 95 dB | | | |
| < 0.004% | 0.004% | < 0.003% | < 0.003% | < 0.003% | < 0.01% | < 0.01% (20 Hz to 15 kHz) |
| Analog (11th-order low-pass) | Analog | Analog | Analog | Analog (11th order) | Analog (low-pass) | Analog |
| | | | | | | |
| > 90 dB | > 90 dB | > 90 dB | > 90 dB | > 90 dB | | 90 dB |
| > 90 dB | > 90 dB | > 90 dB | > 90 dB | | | |
| 2 V | 2 V | 2 V fixed 2-0.05 V variable | 2 V | | | |
| Both 2V | 2 V at 50 kilohms | | 2 V rms at 50 kilohms | 2 V | +4 dBm, +19 dBm (max.) at 8 ohms | +4 dBs (19 dBs max.) 600 ohms, balanced |
| > 10 kilohms | > 10 kilohms | +10 kilohms (fixed) +50 kilohms (variable) | +10 kilohms (fixed) +50 kilohms (variable) | > 10 kilohms | | |
| 28 mW at 32 ohms | 28 mW at 32 ohms | > 8 ohms, 40 mW+40 mW (max.) | 20 mW at 8 ohms |
| Sony Super Strategy/CIRC | Sony Super Strategy/CIRC | Sony Super Strategy/CIRC | Sony Super Strategy/CIRC | Sony Super Strategy/CIRC | Sony Super Strategy/CIRC | Sony Super Strategy/CIRC |
| 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| | | | | | | |
| | | | | | 2 seconds | 2 seconds |
| No | Yes | Yes | No | Yes | Yes | Yes |
| | | 99 countable | 99 | 99 | 99 countable 8 random | |
| Included | Available | Included | Included | Included | | Available ¹³ |
| Infrared | Infrared | Infrared | Infrared | Infrared | | Wired |
| No | Yes | Yes | Yes | | Yes | Yes |
| 4 ¹ / ₄ "·14"·12 ⁷ / ₈ " | 14"·3 ³ / ₄ "·12 ¹ / ₄ " | 17"·4 ¹ / ₄ "·12 ⁷ / ₈ " | 17"·4 ¹ / ₄ "·12 ⁷ / ₈ " | 17"·4 ¹ / ₄ "·5 ¹ / ₄ " | 19 ³ / ₄ "·34 ¹ / ₈ "·22 ¹ / ₄ " | 8 ¹ / ₂ "·3 ³ / ₄ "·18 ⁵ / ₈ " |
| 16 lbs., 9 oz. | 14 lbs., 9 oz. | 18 lbs., 5 oz. | 18 lbs., 5 oz. | 25 lbs., 6 oz. | 115 lbs. | 15 lbs., 14 oz. |
| 30 W | 24 W | 30 W | 30 W | 30 W | 120 W | 30 W |
| Front drawer | Front drawer | Front drawer | Front drawer | Front drawer | Top | Front drawer |

| Brand | Sylvania | Teac | Technics | Technics | Toshiba | Toshiba |
|--|---|---|---|--|---|---|
| Model | FDC303 SL | PD-11 | SL-P7 | SL-P8 | XR-Z50 K | XR-Z79 K |
| Price | \$549.95 | \$649 | \$600 | \$700 | \$599.95 | \$800 |
| Frequency Response | 20 Hz to 20 kHz, ±0.3 db | 5 Hz to 20 kHz, ±0.5 db | 4 Hz to 20 kHz, ±0.5 db | 4 Hz to 20 kHz, ±0.5 db | 5 Hz to 20 kHz, +1 dB, -0.5 dB | 20 Hz to 20 kHz, ±0.5 dB |
| Dynamic Range | > 90 dB | 95 dB | > 96 dB | > 96 dB | 95 dB | 93 dB |
| Signal-to-Noise Ratio (weighted, unweighted) | > 90 dB | 98.5 dB | > 96 dB | > 96 dB | > 90 dB | > 90 dB |
| Total Harmonic Distortion (% at 1 kHz) | 0.004% | 0.001% at 1 kHz | < 0.003% at 1 kHz 0 dB | < 0.003% | 0.003% | 0.007% |
| Intermodulation Distortion (% referred to 0 dB) | < -86 dB | 0.001% | 0.003% | 0.003% | 0.007% | < 0.007% |
| Output Filter | Digital | Digital ¹⁴ | Analog | Analog | Analog (11th order Chebyshev) | Analog |
| Phase Linearity (Angle of Deviation) | ±0.5° | | | | 0° at 1 kHz | |
| Channel Separation (at 1 kHz) | > 80 dB | 90 dB | > 90 dB | > 90 dB | > 90 dB | > 85 dB |
| Channel Balance | < 0.3 dB | < ±0.025 dB | 0.1 dB | 0.1 dB | < 0.5 dB | < 0.5 dB |
| Max. Output Level | 2 V rms | 2.2 V | 2 V | 2 V | 2 V | 2 V |
| Line Output Level (Fixed, Variable) | | | | | 2 V fixed, 0-5 V variable | 2 V fixed, 0-5 V variable |
| Line Output Load Impedance | 10 kilohms | 1 kilohm | > 5 kilohms | > 5 kilohms | 800 ohms | 200 ohms |
| Headphone Output Level (8 ohms, V; 600 ohms, V) | No headphone output | No headphone output | 200 mW ¹⁶ | 25 mW | 25 mW | No headphone output |
| Error Correction (Type) | Interpret & Mute | CIRC | TSDA ¹⁵ | TSDA | SSSECS ¹⁷ | SSSECS |
| Number of Pickup Beams | | 3 | 3 | 3 | 1 | 1 |
| Cueing Time from Pause | | | 5.6 seconds | 4.5 seconds | 2 seconds | 3 seconds |
| Max. Search Time | | | 5.1 seconds | 4.4 seconds | 4 seconds | 4 seconds |
| Programmable? | Yes | Yes | No | Yes | Yes | Yes |
| Max. Track Number Countable | 15 | 23 programmable | 99 | 99 countable 32 programmable | 99 random | 99 countable 16 programmable |
| Remote Control? | Yes | No | None | Included | Included | Included |
| Remote Control Type | Infrared | N/A | N/A | Infrared | Infrared | Wireless |
| Indexing? | | No | Yes | Yes | Yes | Yes |
| Dimensions | 16 ¹ / ₂ "·3 ¹ / ₂ "·12 ¹ / ₂ " | 13"·3 ¹ / ₂ "·11" | 12 ¹ / ₂ "·3 ¹ / ₂ "·12 ¹ / ₂ " | 16 ³ / ₄ "·12 ⁷ / ₁₆ "·3 ¹ / ₂ " | 16 ¹ / ₂ "·3 ¹ / ₂ "·12 ⁵ / ₈ " | 13 ³ / ₈ "·3 ⁵ / ₈ "·11 ³ / ₈ " |
| Weight | 13 ¹ / ₄ lbs. | 8 lbs. | 10.8 lbs. | 13.4 lbs. | 11 lbs. | 15 lbs. |
| Power Consumption | 20 W (approx.) | 12 W | 30 W | 35 W | 16 W | 60 W |
| Disc Loading (Front, Top, Drawer) | Top | | Front drawer | Front drawer | Front drawer | Front drawer |

| Yamaha | Yamaha |
|--|--|
| CD-X1 | CD-2 |
| \$499 | \$599 |
| 5 Hz to 20 kHz, ±0.5 dB | 3 Hz to 20 kHz, ±0.5 dB |
| >95 dB | >96 dB |
| 95 dB ¹⁸ , 100 dB ¹⁹ | 95 dB ²⁰ , 100 dB ²¹ |
| <0.005% | <0.0015% |
| Both | Both |
| >90 dB | >95 dB |
| 0 dB | |
| 2 V at FS | 2 V |
| No headphone output | No headphone output |
| CIRC | CIRC |
| 3 | 3 |
| 3 seconds | 3 seconds |
| 3 seconds | 3 seconds |
| Yes | Yes |
| 99 display 23 sequential | 99 display 12 random |
| No | Yes |
| N/A | Infrared |
| No | No |
| 13½"-3½"-11½" | 17½"-3½"-11½" |
| 17 lbs., 15 oz. | 10 lbs., 9 oz. |
| 20 W | 20 W |
| Front drawer | Front drawer |

Notes:

Akai CD-D1: Auto scan of track beginning.
 Denon DCD-1800: Audible Intro Search, A-B Repeat, Timer Playback.
 Denon DN-3000 FE: ¹From no signal present to maximum disc output level. Includes Cueing, Instant Music Start, Manual Search, and Crosstalk >90 dB at 1 kHz.
 Fisher AD 840: Scanning.
 Fisher AD 844: Scanning, Synchro-record with other Fisher components.
 Kenwood DP-1100B: High Speed Track Search, Indefinite Repeat.
 Kyocera DA-01: Head Location Analog Indicator.
 Magnavox FD 1000SL: Includes demonstration disc.
 Magnavox FD 2000SL: Includes demonstration disc.
 Magnavox FD 2020SL: Includes demonstration disc.
 Magnavox FD 3030SL: Includes demonstration disc.
 Marantz CD73: ²Only included with X-9 system.
 Mitsubishi DP-103: ³Referred to 0 dB. ⁴Referred to -10 dB.
 NAD 5200: ⁵A-weighted deemphasis on. ⁶A-weighted deemphasis off. Features Audible Search (12x normal speed from play) and Nonaudible Search (60x normal speed from pause).
 NEC CD-803: Four-mode Playing Time Indicator, Audible Cue and Review, Time Controlled Auto Start.
 NEC CD-705E: Compartment for remote.
 Onkyo DX-3000: ⁷11-pole low-pass filter. Includes two speed search.
 Pioneer P-D70: Binary/Peak Display Modes, A-B Repeat.
 ReVox B225: 50-command remote control.
 Sansui PC-V1000: Audible Cue and Review, CompuEdit (with Sansui cassette deck).
 Scott 939DA: 88.2 kHz sampling rate.
 Sears 57 AP 9750C: Introskip, A-B Repeat.
 Sharp DX-500(S): ⁸With emphasis. ⁹Without emphasis.
 Sherwood CDP-100: ¹⁰Unweighted at 1 kHz. ¹¹A-weighted IEC at 1 kHz. ¹²7th Order LC Analog plus Double Sampling Rate Digital Filter.
 Sony CDP-101: A-B Repeat, Audible Search.
 Sony CDP-400: Index Search, Audible Track Scanning.
 Sony CDP-610ES: 2-Speed Search, Audible Track Scanning, Cleaning Cloth.
 Sony CDP-701ES: Music Scan, 2-Speed Search, Real Time Access.
 Sony CDP-5000: Professional model for use with CDA-500 Analyzer. Includes 10-key direct access, 2-speed manual search.
 Sony CDP-3000: ¹³Remote Control necessary. Player for professional radio use. Can be slip-cued.
 Sylvania FDC303 SL: Includes demonstration disc.
 Teac PD-11: ¹⁴Plus 7th Order Analog LC Filter. Features A-B Repeat, Timer Auto Play, Auto Pause.
 Technics SL-P7: ¹⁵Technics Super Decoding Algorithm.
 Technics SL-P8: ¹⁶32 ohms (adjustable). Features Timer playback, Real Time Access, Pitch Control.
 Toshiba XR-Z50K: ¹⁷Super Synthesized Syndrome Error Correction System.
 Toshiba XR-270K: Auto Pause.
 Yamaha CD-X1: ¹⁸Flat (1 kHz). ¹⁹IECA (1 kHz). Features single play mode.
 Yamaha CD-2: ²⁰Flat (1 kHz). ²¹IECA (1 kHz). Features single play mode, 88.2 kHz sampling rate.

All prices and specifications have been provided by the manufacturers and are subject to change without notice. Prices are the manufacturers' suggested retail. New CD players from NAD, Magnavox, Hitachi, Quasar, Emerson, Empire, Sharp, and Technics were introduced after press time. Look for news about these and other units in upcoming issues of *Digital Audio*.

Sony's 610ES:

Practical Benefits, Natural Sound

by W. Charles Doherty

With the 610ES, Sony takes a top-of-the-line approach to CD player design at a middle-of-the-road price. The 610ES's features are smooth, precise, and built with an eye toward the future.



Sony's 610ES boasts superb design and flawless sound reproduction.

Sony CDP-610ES Compact Disc Player

Manufacturer's Specifications

Frequency Response: 5 Hz to 20 kHz, ±0.5 dB

S/N Ratio: >95 dB

Dynamic Range: >95 dB

Channel Separation: >90 dB

Total Harmonic Distortion:
<0.003% at 1 kHz

Maximum Output Level: 2 V

Number of Programmable

Selections: None

Remote Controller:

Included with unit at no extra charge

Power Consumption: 30 W

Dimensions: Approx. 17" x 4½" x 12¾"

Weight: Approx. 18.5 lbs.

Price: \$850

Company Address: Sony Consumer Products Company, Sony Drive, Park Ridge, NJ 07656

Listen to the Sony CDP-610ES. Operate its controls. When you do, you'll begin to appreciate the subtleties of its superb audio engineering and its elegantly simple controls. No detail has been overlooked in this second-generation CD player.

For \$850, you get much of the same technology in the 610ES that Sony developed for its top-of-the-line models. Many parts, including the power supplies, line and buffer amplifiers, and low-pass filters, are identical to those in the \$1500 CDP-701ES.

The 610ES is built to last. There's no hint of flimsiness, from the main power switch to the various programming buttons. It's a hefty machine (measuring 17 inches W by 4½ inches H by 12¾ inches D and weighing 19 pounds), but it's easy to stack on (or under) most amplifiers.

Operation Made Easy

The 610ES's motorized, front-loading

drawer opens and closes without a long wait. This smooth and precise mechanism lacks the "cheapness" found in some other front-loading machines. After inserting a disc, just touch the play button to close the drawer and start the playing mechanism.

However, if you're clumsy and you place a CD on the edge of the drawer rather than in the middle, closing the disc compartment can jam the disc between the front panel and the drawer. This can put a deep scratch in the disc surface and cause mistracking. (It's not likely to happen, but it is possible.)

The more frequently used controls (Play and Pause) are larger and are logically positioned in easy-to-reach locations. So are the skip forward and skip back buttons.

The fast forward and "fast backward" buttons allow you to search at two different speeds in both forward and reverse directions. With the larger button, the read head moves at approximately

20 times normal speed, and with the smaller button, about three times normal speed.

In addition, this manual search control permits you to hear the music while you are fast-forwarding within a track. A versatile repeat function also allows replaying of an entire disc, a single cut, or any section.

On the top right of the control panel is a time indicator that shows either elapsed time or time remaining. This indicator helps you find a particular section of a recording with the manual search controls.

Another interesting feature of the 610ES, the auto pause switch, puts the machine into the pause mode at the end of every track. This control allows you (or a radio disc jockey, although Sony makes a professional-use model, the CDP-3000) to pause after playing one song. This makes it easy to tape your favorite cuts from various CDs.

The front panel also features a headphone jack with variable volume, a pause control, a main output level adjustment, and a stop/reset button.

Remote-Control Volume

All of the 610ES's controls (with the exception of the power switch and the disc drawer control) are duplicated on a hand-held remote control. An audible "beep" sounds from the player each time you press a button, confirming that it received the infrared signal. If you prefer not to hear it, a switch on the rear panel of the main unit defeats the beep.

The lack of a volume control on Sony's earlier remote equipment was annoying. Sony must have known it, because the 610ES remote control does include a volume control. The volume knob on the CD player, driven by a servo motor, turns as you change the volume from the remote terminal.

Because the remote control is infrared, it requires a clear line of sight to operate. In addition, angles greater than 70 degrees may prevent the player from receiving the control signal.

Connecting With the Future

Sony designed many of the 610ES's features with an eye toward the future. The index mechanism can move the laser pickup to read subcoded passages within a disc. As many as 99 of these index points are available and waiting for the industry to make use of them.

On the back of the player is an accessory connector for home computers and video displays. We soon may be seeing discs that hold more than just music.

The CD's data structure permits it to incorporate such things as jacket notes, song lyrics, and still pictures (all viewable on a video monitor).

Video games, instructional discs, and other computer software could have CD-quality sound effects and spoken material. Although no discs with these features are commercially available now, the 610ES won't become obsolete when these CDs appear on the market (see "The CD-Micro Connection" on page 18.)

Clearly a Natural Sound

The specifications of this—or any—CD player tell little about how it sounds. But two players with identical specifications may sound different when compared side by side.

The 610ES's amplifier circuitry produces almost no background noise, even with the gain set to full.

I listened to the 610ES through a Carver receiver and a pair of ADS L1090s and compared its performance to several other CD players in the same basic price range. The most obvious difference I found was that the 610ES is less harsh than some CD players. At the same time, musical transients come through a bit more sharply and clearly. Even passages filled with brass instruments remain natural and uncolored compared to the slightly metallic and biting sounds I heard on a couple other CD players.

Stereo image is rock-solid, especially in the lower registers. Drums can be heard with dynamic presence and clarity. The CD's inherent absence of background noise adds to an overall illusion of reality.

The 610ES's amplifier circuitry produces almost no background noise, even with the gain set to full. Any noise that is present is so far below the quietest signal level that it's almost nonexistent. Even the slight "purring" of the motor drive is unnoticeable unless you're sitting within a foot of the machine during quiet passages.

With damaged and flawed discs, the

610ES is considerably more forgiving than most players. In a test of the machine's tracking ability, a flawed CD was played on both the 610ES and on a \$1400 player from another manufacturer. The flaw made the CD unplayable on the \$1400 machine, but the 610ES played the disc without muting or mistracking.

With damaged and flawed discs, the 610ES is considerably more forgiving than most players.

Thoughtful Additions

Setting up the 610ES is uncomplicated. The connecting cable plugs into an auxiliary input of an amplifier; the other end of the cable connects to either the "variable" (affected by the output level control) or "fixed" output of the 610ES. Sony supplies a connecting cable of unusually high quality (oxygen-free high conductivity copper). Both the cable and the player's terminals are gold-plated for lower noise—especially thoughtful touches.

Sony also provides a clear and thorough manual, including easy-to-follow instructions for hook-up and operation. Further, a testing report showing the actual performance of your unit is included. In most cases, the 610ES fares better in the test results than in the published specifications. And Sony supports its product with a three-year parts and labor warranty.

Practicality Plus

Currently, there are dozens of Compact Disc players available. Some manufacturers tout their machines' unique operating features, while others point to technical innovations. Sony takes a middle-of-the-road approach with practical benefits in mind.

The result: the 610ES is one of the better-sounding players in its price range, and it outperforms many machines costing hundreds of dollars more. □

W. Charles Doherty, a veteran of 10 years in sales and service in the audio industry, writes Digital Audio's news column, "Bits and Pulses."

History of Sony CD Players

It's little wonder that Sony has sold more consumer Compact Disc players than any other manufacturer. After all, Sony Corp. and North American Philips developed the Compact Disc format. Sony was also the first company to introduce the Compact Disc player in the U.S. (1983). And at the Consumer Electronics Show this summer, Sony demonstrated the first two car CD players—the CDX-5 and the CDX-R7.

As you might expect, Sony markets the most extensive line of consumer and professional CD players available. In addition to the CDP-3000, designed for radio station use, and the CDP-5000, used for testing and analysis of discs, Sony manufactures five consumer CD players. The differences between the players are small, but significant.

In keeping with Sony's marketing strategy, there is something for everyone. According to Sony, each player is targeted at a slightly different market.

- CDP-101—The one that started it all. The first commercially available Compact Disc player in the U.S. The 101 is a first-generation machine that uses a ninth-order analog filter. Its features include an A-B repeat and audible search. Sony calls the 101 a "midi-size" unit, which means it is smaller than most hi-fi equipment. Sony markets a cabinet to adapt the 101 to the conventional equipment size for stacking. Suggested retail price: \$900.

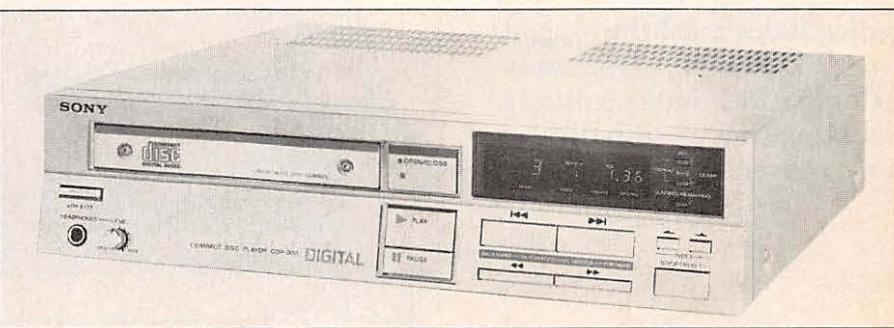
- CDP-200—The least expensive Sony model, the 200 is a second-generation, non-programmable player with A-B repeat and audible search. The filter is an eleventh-order low-pass (analog) type. Suggested retail price: \$700.

- CDP-400—Sony's most recent addition, the 400 is a step up from the 200. A wireless remote and an elapsed time and remaining time display are included. This model is also compatible

with external timers and has auto pause and a three-speed search. Suggested retail price: \$800.

- CDP-610ES—See the preceding article for a detailed report on Sony's lower-priced audiophile CD player. The 610ES is a second generation machine that employs an eleventh-order filter. Suggested retail price: \$850.

- CDP-701ES—The top of the line. Designed for the audiophile, this model has just about every conceivable feature. The 701ES uses a dual monaural system. From the digital/analog converters to the outputs, the signals travel in identical but separate paths, which Sony claims improves stereo separation. Among the features are: separate headphone and line output volume controls, a full-function wireless remote, and a three-year warranty. Suggested retail price: \$1500.



The CDP-200 is Sony's least expensive consumer CD player.



The CDP-400 is marketed with a wireless remote.



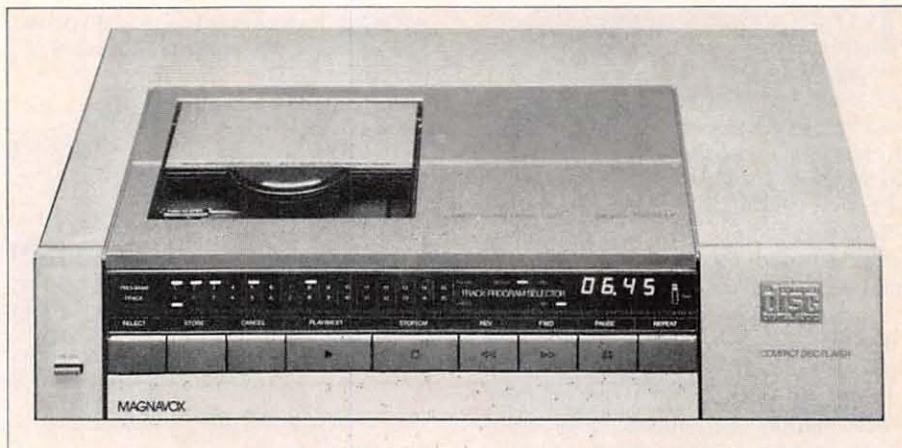
Sony's top-of-the-line consumer CD player is the \$1500 CDP-701ES.

Magnavox's FD2020 and FD3030 CD Players:

Magnificence in Sound and Sight

by Tom Krehbiel

The Compact Disc is a mass market item, and Philips of Holland kept that in mind when it designed the Magnavox FD2020SL. This user-friendly unit looks, sounds, and operates as smoothly as any player.



The Magnavox FD2020: high-quality sound for \$699.

Magnavox FD2020SL Compact Disc Player

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ± 0.3 dB

S/N Ratio: >90 dB

Dynamic Range: >90 dB

Channel Separation: >90 dB

Total Harmonic Distortion:

<0.004% at 1 kHz

Maximum Output Level: 2 V

Number of Programmable Selections: 15

Power Consumption: Approx. 27 W

Dimensions: Approx. 16½" x 3¾" x 12"

Weight: Approx. 13.2 lbs.

Price: \$699

Company Address: NAP Consumer Electronics Corp., I-40 and Straw Plains Pike, Knoxville, TN 37914

Reviewing a Magnavox Compact Disc player is like reporting about a Thomas Edison phonograph. Magnavox's corporate parent, Philips of Holland, is entitled to most of the credit for coming up with the Compact Disc. So its hardware offerings have to be regarded with some respect.

No Tinfoil

In more than 100 years of recording sound, the digital CD represents the only development that isn't merely a variation of what the Wizard of Menlo Park created when he etched "Mary Had a Little Lamb" on a tinfoil-wrapped cylinder. So I'd like to take a brief look at the idea that lies behind the Magnavox FD2020 before getting to the specifics of the player's operation.

Simply put, audio is recorded digitally with a set of descriptive statistics. These statistics are derived by sampling the music's waveform tens of thousands of times every second. When we play back digitally recorded music, we read the statistics and use them to reconstruct the music waveform.

Why go to all this trouble? Because the music is relatively immune to outside interference when recorded in this form. Think of it as similar to the list of letters and numbers composing the instructions for knitting a sweater.

The paper containing the list may become soiled, wrinkled, even torn in spots. But as long as the instructions are readable, a skillful person can construct a perfect sweater. As a matter of fact, an experienced knitter can even make good guesses at the instruction codes that are missing or totally obscured. Similar sorts of error correction data form a major part of the digital audio process, too.

In the case of CDs, the numbers are etched on a reflective surface by a laser beam and are read back with a similar laser. The quantity of numbers involved—44,100 for every second of music—requires computer technology.

Thus, a CD player is essentially a small computer dedicated to audio reproduction. And that, in turn, means that it's relatively easy for manufacturers to include various computer-

driven memory and display functions in their CD players.

Magnavox has done this with the model FD2020 in a particularly logical and easy-to-operate way. You might be tempted to look for a "CD literacy" course to help you operate some players, but that's not the case with the FD2020.

The bottom part of this player's front panel has a neat row of nine buttons that control all operating functions. Many of these buttons are marked like, and work like, the controls on cassette decks.

There's one marked Play, another marked Stop, and a pair for high-speed scanning [Fwd and Rev]. The play button is also labeled Next; when pressed, the laser will skip to the next track. It's kind of like pushing the reject button on your old Capehart while playing a stack of 78s.

No Comparisons

It isn't quite fair to make comparisons between a CD player and a conventional turntable, since, at this stage of the game, we have to consider CDs a supplement to LPs rather than a replacement for them. But I can't help pointing out that these first four buttons and their five easy functions are enough to make the FD2020 much more convenient to use than any LP turntable.

There's a display area on the front panel above the control buttons. It has a time counter at the right end and two rows of green LEDs to the left. The entire upper set of LEDs lights up when power is turned on, but some turn off later to show the effects of programming. The lower set of LEDs lights up one at a time as a programming aid and works in conjunction with the select button.

Don't Be Afraid...

Now don't let the word "programming" scare you. The Magnavox folks have made the process as easy as deciding what song you want to hear next.

For instance, to start a disc somewhere other than the first track, just tap Select and watch the lower green bars move from track number to track number. Stop when the track number you want is lit, then hit Play. (I didn't even have to read the instructions to figure this one out.) When you do this, by the way, the upper-level LEDs corresponding to the tracks you skipped go off to indicate that those songs won't be heard.

The select button has two helpers:

Store and Cancel. The first is used to select other tracks you want to hear. The second is used to weed out those you don't want to hear. That's the button I really like.

You know how it is. There's always at least one song on a record that just doesn't make it. With the FD2020, all you have to do is tap Select until the LED under the unwanted track lights up; hit Cancel and then Play. The disc plays, but the unwelcome music is skipped over. You can cancel more than one track if you want.

The store function's method of operation is the same as the cancel function's, but it has the opposite effect. The track that is indicated when you hit Store is programmed into the play list, rather than out of it. Use this when there are only one or two pieces on a disc that you want to hear.

There are 15 track-indicating LEDs, so the programming functions on the FD2020 can deal with no more than 15 CD tracks. So far, this is not a serious limitation, but it may not be long before discs appear with more tracks than the FD2020 can access directly. (How long will it be before K-Tel offers "A Double Dozen Digital Ditties" for \$10.98 at your neighborhood drugstore?)

The pause button does precisely what you would expect. The music stops, but the disc keeps spinning and the laser remains in position to pick up where it left off. A second touch of the pause button restarts the music.

Pressing Repeat allows the entire disc, or only selected tracks, to play indefinitely (I have the same function on my turntable and have never used it, but I guess some people can't get too much of a good thing).

Real Relative Time

There's also a time display on the FD2020. It normally shows what Magnavox calls "relative time"—the number of minutes and seconds that have elapsed on the track currently being played. Push a button and the display switches to "absolute time," indicating the total time since the beginning of the disc, including pauses between tracks.

The time function, by the way, doesn't actually measure the minutes and seconds ticking away. Time signals are encoded on the disc itself, and the player reads these directly. As you scan forward or backward over a portion of a track, you'll see the time display changing rapidly in a manner similar to the counter on a cassette deck.

The concern of Philips' design engineers in making the FD2020 easy to use shows in more places than the programming functions and displays. Another indication is the simple disc-loading arrangement.

On the FD2020 and other Magnavox players (except for the FD3030), a little trap door on the top floats open, at a touch, to reveal a spindle that fits the center hole of a disc. Drop the disc over the spindle, push the door closed, and you're ready to go. A trap door isn't as "high-tech" as a motorized drawer or a flip-out slot, but I find it more convenient to use. Some of the drawer arrangements I've used seem slow and cumbersome by comparison.

The only disadvantage I see in the top-loading system is that it requires the player be placed on a table top, on top of a system rack, or installed in some other location where there is enough clearance above to get to the hatch. The unit also generates a fair amount of heat that is dissipated through vents on top—another good reason to leave plenty of room above it.

One real convenience is having the signal cables already attached to the back of the player. Other nice touches are the demonstration CD included with the user's manual, a "disc duster" cloth, and a handy pocket in the manual binder to store the transport screws that must be removed before using the player. None of these are earth-shaking by themselves, but collectively they show Magnavox's welcome concern for its customers.

Mass Market Appeal

Magnavox also gives a clue (as if I didn't know) as to whom it expects its main CD customers to be. Philips has made no secret of the fact that it views digital audio as a mass market rather than elite audiophile product.

This is reflected in the FD2020 right in the choice of the brand name. "Philips" is a better-known high fidelity name, but "Magnavox" has broader general consumer recognition and respect. The top-accessed hatch and spindle arrangement, a joy to use, reminds consumers of the familiar turntable design; it's definitely not for semi-pro rack-mount fans. And the permanently attached output cable on the back offers no chance to "improve" this unit by substituting gold-plated connectors and extra-heavy wiring.

But there's never much chance that a product designed to supply superb sound with little fuss and bother will be

welcomed by the "tweaks." And indeed, the caterwauling about "digital madness" among fans of the audio industry's more esoteric offerings is like nothing heard since the application of the transistor to hi-fi gear.

I'd say that Philips is right on the mark by catering its initial CD hardware to a broader range of consumers.

The Sound of Music

What about sound quality? Some of the tracks on the Magnavox sample disc show the shortcomings inherent in the reproduction of the software—not the hardware.

Tom Jones' "Green Green Grass of

Home" sounds pretty dull and tubby. But "Funkytown" by Lipps, Inc. crackles, and John Williams' "Star Wars—Main Title" blasts out convincingly. The other recordings I auditioned, from jazz to classical to new wave rock, make it clear that the FD2020's sonic performance will delight any music lover.

With excellent recordings the FD2020 sounds appropriately lifelike. I particularly enjoyed springing Magnavox's digital sound on unsuspecting music lovers. One noted ruefully that he had nearly worn out the word "incredible," but said that he couldn't think of any other way to describe what he was hear-

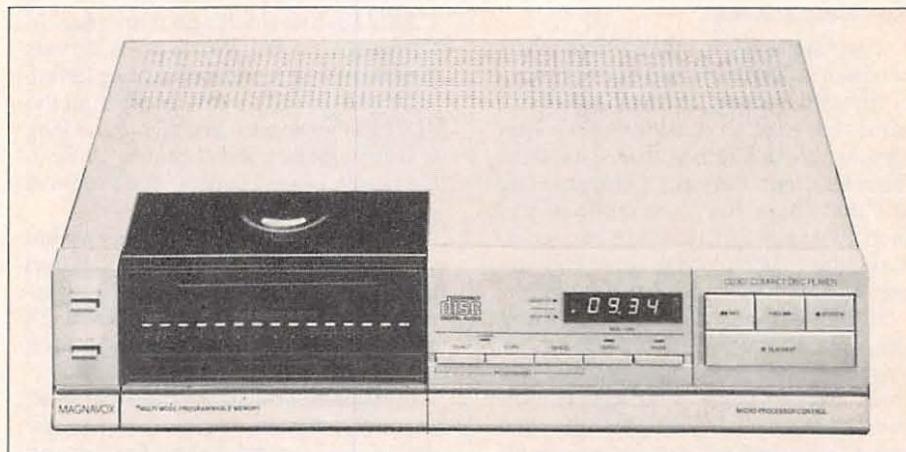
ing. Another said he'd never leave the house if he had something like the FD2020 at home.

In summary, this player's easy programmability works, with the silent background so characteristic of digital audio, to tear down any barriers between the user and the music. Listening at home becomes a new experience. With the Magnavox FD2020, Philips has provided us with a practical lesson on how to design and build a "user-friendly" CD player. □

Tom Krehbiel writes a regular audio column for the Buffalo Evening News.

by Steve Birchall

Stunning—that's the word for the Magnavox FD3030SL. Its elegant, seductive sound quality shows off the performance level and potential of the CD.



The Magnavox FD3030 creates the illusion of a live performance.

Magnavox FD3030SL Compact Disc Player

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ±0.3 dB

S/N Ratio: >90 dB

Dynamic Range: >90 dB

Channel Separation: >90 dB

Total Harmonic Distortion:

<0.004% at 1 kHz

Maximum Output Level: 2 V

Number of Programmable Selections: 15

Power Consumption: Approx. 27 W

Dimensions: Approx. 16½" × 3½" × 12½"

Weight: Approx. 17 lbs.

Price: \$799

Company Address: NAP Consumer Electronics Corp., 1-40 and Straw Plains Pike, Knoxville, TN 37914

The sound of the Magnavox FD3030SL is spectacular. It has the clean, clear, and undistorted qualities you would expect from a second-generation CD player. The live performance illusion it creates is truly thrilling.

Although I like the sound, Philips has a concept of sound quality with which I am not in total sympathy. But remember that this is an area of personal taste and individual differences, so don't misread these remarks as a negative evaluation. What I am doing at this point is defining the sound.

Safe Edges

Philips always has had a tendency to back away from knife-edge detail. In its analog recordings, this has been a consistently observable approach to sound.

The same has been true of its hardware (which is not as widely known in this country as its software).

Perhaps it's simply a corporate preference, or perhaps it's a reflection of Dutch taste in general. I think of that deliciously soft taste of Dutch chocolate. It's a viewpoint that says whenever something has a sharp edge, remove any potential for impressions of discomfort (or even danger) by rounding the edge, however slightly.

Not surprisingly, Philips' CD player has that same characteristic, that same slightly rounded elegance. Many people prefer this kind of sound, and it certainly is seductive; but personally I prefer a sound quality with knife-edge definition. Sony's CDP-610ES is an example of this style of sound. However, I think

people who like the mellowness of tube amplifiers will find the Magnavox more amenable to their tastes.

The sound field the Magnavox projects into a room has impressive spaciousness and depth. Although not quite so cinematic as the Sansui PCV-1000 or the Sony 610ES images, it ranks within the top group in this respect. The Hitachi DA-800, by comparison, lacks the depth and openness of the Magnavox and belongs in the next category down.

Most of a CD player's imaging problems arise in the analog end of the decoder—particularly in the anti-aliasing filters. The ability of these filters to pass phase information accurately is crucial to the feeling of depth. All analog filters increase the phase error as the frequency increases. Generally, the steeper the cutoff slope, the greater the percentage of phase error.

Dynamic range is thrilling on a CD, and the Magnavox player reproduces it in all of its untrammeled glory.

The second generation of CD players (the FD3030 is an example) use digital anti-aliasing filters. The almost palpable stereo image they can project between your speakers is absolutely wonderful. Those discs that have a distinctive and identifiable "hall sound" tend to sound excellent on the Magnavox. The differences in sound from one recording location to another are among the most obvious and enjoyable aspects of the CD listening experience; the Magnavox player reproduces them beautifully.

Infinitesimal Differences

Before commenting on the FD3030's subjective frequency response, I want to say that the differences you'll hear are audible, but nearly infinitesimal compared to the differences you're used to hearing on analog equipment. The effect is like talking about something measured in volts and suddenly having to jump to microvolts to find differ-

ences. The verbal descriptions seem similar, but they're in the context of a much weaker level of intensity.

Bass on the FD3030 is just a bit tubby, as if some part of the circuit had a slight ripple in this area. The extreme highs lack some of the clarity I'd like to hear. Throughout some 90 percent of the range, the player seems to have ruler-flat frequency response, but at both ends it has a slight rising tendency.

Dynamic range is nothing short of thrilling on a CD, and the Magnavox player reproduces it in all of its untrammeled glory. I have listened to it at levels that made the loudest passages uncomfortable, and I have listened at background music levels. In both cases, the medium's freedom from noise and distortion makes listening a real pleasure.

On recordings that have a wide dynamic range, the detail in the soft passages is surprising. What a pleasure to hear the most subtle orchestral sounds and to know that a random static pop, pressing defect, or omnipresent gaussian surface noise won't spoil the illusion of reality.

At the other end of the range, I appreciate the lack of distortion on loud passages—a sound quality so closely associated with recorded music that its absence is surprising. The limitation now lies in my amplifier and speakers, not in the storage medium.

Nobody's Perfect

Some of the things I didn't like about the Magnavox concern user interfacing. The lid that covers the disc during play and lifts up when the drawer is open makes disc insertion and removal a bit awkward. Also, you must close the drawer before the play button will work. I'd rather have the play button take care of closing the drawer for me.

The location of the drawer closing switch, just above the power switch, is a bit inconvenient; it requires you to use your left hand or to reach across the open drawer at an awkward angle. Why not put a big easy-to-find button just to the right of the drawer?

On the other hand, I like the separation of the transport controls from the programming controls, and the differentiation between the two groups in size and shape. But the pause control seems misplaced—it should be in the transport group.

Further, the references to "absolute" and "relative" time on the front panel indicator are confusing. At first, I expected absolute time to be the time of

day and relative time to be the amount of time the disc had been playing. More functional descriptions for these indications would be "remaining time" and "elapsed time."

The most disturbing aspect of this unit is the amount of RF leakage. The FD3030 obliterates all TV channels below 7 whenever it's on. This is inconvenient to others in the house or apartment building, prevents "time shift" taping of video programs, and so on. Judging from the success of other manufacturers in controlling RF leakage, Magnavox should give some consideration to this performance parameter.

*The Magnavox
FD3030 is a stunning
piece of equipment.
It displays the potential
of the CD in its
current state of
development at a
high level of sonic
perfection.*

Documentation

The owner's manual is one of the nicer packages I've seen in consumer electronics equipment. It comes in a molded plastic case that opens like a book. Inside are pockets to hold a disc cleaning cloth (a thoughtful accessory) and a sampler disc (thanks again, Magnavox). Loose-leaf, transparent binder pages hold the manual itself, along with safety, warranty, and repair information.

The manual is clearly written in American English, not in literally translated Dutch. You can spot the section you need to read just by looking at the photos. The nicest touch is the recessed well for storing the transit screws (most people throw them away or forget where they put them). I was also happy to see the reminder not to plug the player into a phono input.

The Magnavox FD3030 is a stunning piece of equipment. It displays the potential of the CD in its current state of development at a high level of sonic perfection.

Toshiba's XR-Z70K: A New Standard in Sound

by Mike Apsey

Toshiba's XR-Z70K offers convenient features and a clean design, but what stays on your mind is the crystal-clear sound.



Toshiba's XR-Z70K was originally available in black or silver; it's now being produced only in black.

Toshiba XR-Z70K Compact Disc Player

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ± 0.5 dB

S/N Ratio: >90 dB

Dynamic Range: >93 dB

Channel Separation: >85 dB

Total Harmonic Distortion: <0.007% at 1 kHz

Maximum Output Level: 2 V

Number of Programmable Selections: 16

Power Consumption: Approx. 60 W

Dimensions: Approx. 16½" x 3½" x 12¾"

Weight: Approx. 15 lbs.

Price: \$800

Company Address: Toshiba America, Inc., 82 Totowa Rd., Wayne, NJ 07470

I pushed the power button, and the Toshiba XR-Z70 came to life with the cleanest digital readout I have seen on any Compact Disc player. In comparison, displays on other players look fuzzy and out of focus.

Listening to the Toshiba was an introduction to digital audio all over again, and I loved it. The music I pumped through the Toshiba came out uncolored, crisp but not harsh, solid but not boomy, loud but not biting, full but not peaky, and not just quiet, but silent.

To describe the XR-Z70's sound compared to a turntable's is like comparing apples and oranges. The Toshiba wins, hands down. To compare the Toshiba to other CD players becomes more difficult.

Unlike analog components, digital audio players present a nearly uncolored signal to your system. Colorations that do exist usually can be traced back to the disc itself. Current CD players all use similar technology and generally sound surprisingly similar. The differences are primarily in the

quality of the circuits at the analog end of the player.

Among the dozen or so CD players I have carted home and tinkered with, this unit has become the standard against which I judge the others. This is especially true in the features department.

Special Features

The XR-Z70 features a welcome option: two search speeds. One speed is six times faster than the other; and it's engaged by operating the fast forward/reverse buttons while the player is in pause. Both speeds are fast, and they allow you to hear the search. Once you've discovered that option, you'll never want to be without it.

The pause feature is special, too. On all current CD players the disc keeps spinning while Pause is engaged. Forgetting to disengage the pause can cause excessive motor wear. The XR-Z70, however, automatically stops the disc after 60 minutes in pause. If a track is selected followed by a push of the

pause button, the laser moves to the new selection before pausing.

Selecting a track to play is easy. Simply press the button corresponding to the desired musical piece, and then press Play. The system moves quickly to the new selection and begins playing.

Skipping up to a later selection or down to a preceding one is possible. Some players only skip forward. In addition, the XR-Z70 skip feature can remember how many times you have pressed the skip button, and step repeatedly.

Two output jacks appear on the rear apron. The first is a normal line output, the second a variable output. By selecting the variable output, you can control the output level of the XR-Z70 with its headphone volume control. In this way, your CD output level can be matched to other system components.

The motor used to spin the CD is whisper-quiet. You'll have trouble evaluating motor noise in a busy showroom, but it's an important consideration in the dead of night in your listening environment. Even the sound of the laser movement while searching is minimal.

Once a CD begins to play on the XR-Z70, it will repeat continuously until halted. Many other players stop when the disc has played through, or require engaging the repeat option. An auto-pause feature can be engaged on the XR-Z70 to stop the player after each selection until play is manually resumed.

This player also allows for CDs containing up to 19 selections. (Many other players support only 15.) Up to 16 selections can be stored in memory to play in any sequence and repeat. Some CD players allow selecting certain tracks but will play your selections only in the order they appear on the disc.

Although the XR-Z70 supports indexing, none of the CDs I own make use

of indexing information. This feature allows programming specific sections within selected movements. Without indexing, you must start each selection at the beginning, and then fast-forward to the desired starting point.

The XR-Z70 is moderately immune to vibrations and performs well on its side or even upside down. Aggressive attempts to make the player miscue were only mildly successful.

Mickey Mouse Manual

The operating manual illustrates the various functions using comic book sketches of the XR-Z70 with Disney-like gloved hands pressing various buttons. I found it distracting, frustrating, and insulting. The documentation is saved only by a center-spread containing help for grown-up users. But some kind of index would be nice.

In addition, figuring out how to use

the memory features is difficult. The answers are all in the manual, but it takes some hunting to find them.

Toshiba didn't send the remote control unit with the review model. Further, the XR-Z70 requires an external timer to shut down automatically. The optional timer does allow a unique option feature: Auto Start. Imagine being able to use a CD player as a "clock radio."

A 4.8-Star Rating

The Toshiba XR-Z70 is a great-sounding, good-looking, feature-packed CD player I wouldn't mind owning. The features are important because they are missing from many similarly priced players.

Test the XR-Z70 before you buy something else. If a five-star rating was tops, this player pulls a 4.8, losing two-tenths of a point for the dumb owner's manual.



A New Digital Recorder Challenges PCM

by Dave Hadaway and Steve Birchall



The dbx 700 uses the PCDM encoding system—the first serious departure from PCM.

With a sampling rate of 644 kHz, a dynamic range of 110 dB, and an innovative new encoding method, the dbx 700 poses an interesting challenge to the digital "establishment."

The Companded Predictive Delta Modulation (CPDM) system is the first serious departure from Pulse Code Modulation (PCM) to appear on the market. It avoids the expensive, steeply sloped anti-aliasing filters that PCM systems require, and it uses less expensive filters with fewer negative effects on the signal.

Essentially, the dbx Model 700 is the electronics of a digital audio recorder. You can send the NTSC-formatted output to any video deck for recording. In broadcasting applications, it functions

as a noise reduction device in transmission links. The dbx company also has announced the availability of CPDM circuit cards for other manufacturers who want to use the dbx system in digital tape recorders.

The CPDM sound quality is similar to the familiar PCM systems, but it has its own character. No longer can we use the terms "digital" and "PCM" interchangeably, since we now have an alternative system against which to compare the performance of the PCM devices.

How Delta Modulation Works

If you remember the early digital delay lines sold for home use (such as the Audio Pulse), you should be familiar with delta modulation. These delay

lines used a simple form of digital sampling, which encodes the change in level between two samples. (In mathematics, the term delta indicates change in a variable, thus "delta modulation.") The problem is that it's inherently noisy. For delay lines feeding rear speakers playing at low levels, this wasn't especially objectionable, and the cost was low.

To cure the noise problem, circuit designers developed adaptive delta modulation. This system changes the size of the step between samples, adapting it to rapidly changing signals. If the signal is increasing or decreasing in amplitude at a rapid rate, adaptive delta modulation provides smaller step sizes between samples. But if the signal's am-

plitude is changing slowly, the sampler reverts to larger step sizes. This system works much better, but you can hear slight changes in the coloration of the residual background noise.

Robert Adams and his engineering team at dbx refined adaptive delta modulation still further by increasing the sampling rate significantly, adding linear prediction techniques, and using a digitally linked companding system. With linear prediction, the encoder guesses the best size for the step, based on the recent past of the signal. It can adapt to rapidly changing signals, thus avoiding the noise and distortion of the simpler methods. They went one step further and added a companding circuit to improve the s/n ratio still more. That, in a nutshell, is Companded Predictive Delta Modulation.

Because it has a digital link between the compressor and expander, it tracks precisely and avoids most of the "pumping" or "breathing" problems of purely analog companders. However, in the presence of high-frequency information, the noise floor rises and is clearly audible on test tones (sine and square waves). With typical musical signals—which are always changing—this doesn't happen, and the noise floor is inaudible. With a steady-state test tone, the CPDM system has difficulty, because it can't do its tricks and adapt step sizes. So the noise becomes audible.

Bench Testing the 700

Frequency response is difficult to measure on a CPDM system. Steady-state sine wave test tones at various frequencies confuse the system, so we used sweep tones. We ran sweep tones at various levels and found the 700 flat within a few tenths of a dB.

At -10 dB, when the sweep tone reached the high frequencies, a very audible amount of noise occurred, and above 20 kHz, a "birdie" chirped. We attribute this to some kind of overload problem. Since the 700 is designed to work best with real-world musical signals, these problems in the high frequencies aren't objectionable. The amplitude distribution of acoustical musical signals shows a rapid decline starting at 5 kHz—in other words, not much information above 15 kHz is present in acoustical musical signals.

Square waves present other difficulties to the CPDM system. We recorded and played back a 1 kHz square wave, and it looked so noisy on an oscilloscope that we couldn't realistically compare the 700's ringing and overshoot with the

Sony PCM-F1's performance. Also, the band limiting filtered out enough of the upper partials (on a square wave they go out to infinity) that the waveform on the scope appeared to have a large amount of ringing. We estimated the overshoot at about 30 percent, compared to 40 percent on the Sony F1. No significant amount of ringing was evident. Once again, the 700 works best with music, not with test tones.

dbx 700 Digital Audio Processor

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ±0.5 dB (sine wave or pink noise, 100 mV input, reference recording position)

Dynamic Range (Weighted):

Typically 110 dB (Maximum rms signal at 1 kHz to A-weighted noise, 20 Hz to 20 kHz)

Dynamic Range (Unweighted):

>105 dB

Total Harmonic Distortion:

<0.05% (1 V input at 1 kHz)

Sampling Rate: 644 kHz

Wow and Flutter: <0.01% unweighted, <0.006% wrms

Anti-aliasing Filters: -3 dB at 37 kHz

Bit Rate: 644 Kbits/second

Maximum Input/Output Levels:
+24 dBm

Power Consumption: 60 W

Dimensions: 19" x 5 1/4" x 11 1/2"

Price: \$4600 (mike preamps
\$370/pair extra)

Company Address: dbx Inc., Box
100C, Newton, MA 02195

We asked dbx's Adams about the problems of measuring the 700's performance. He suggested that most of the noise, when viewed on a spectrum analyzer, would be out-of-band noise. Repeated toggling of the transient speed-up circuit (which controls the voltage-controlled filter in the delta modulator) causes it. The wider frequency response of the 700 allows more noise to be seen on a scope or spectrum analyzer, but most of it is above the range of human hearing.

We compared error correction using a full amplitude 20 Hz test tone recorded on a deliberately mangled video cassette. The F1 performed better because of its interleaving scheme. On music, however, the errors generated with the 700 should be better concealed by the

program material, since they are Least Significant Bit (LSB) errors. The F1 can generate full amplitude errors with no signal. To be fair, the test should have been repeated with "no signal" recorded, and the 700 would have performed better.

The 700 does have muting, but it mutes for a shorter time than the F1 does. If it sees something plausible, it lets it through, because, at times, random noise can look like data. ("Silence" in digital terms is a recorded string of 1s and 0s.) The copy mode has no error correction simply because it would have added to the cost of the unit.

Live Recording

We had an interesting opportunity to test the dbx 700. The occasion was an orchestral concert in a fairly "dry" hall. We ran the dbx 700 in parallel with the Sony PCM-F1. The video decks were a Sony 2700 and a Sanyo 7200 (both are Beta Hi-Fi machines). The mikes were Nakamichi CM-1000 omnidirectionals, used in a spaced pair configuration. The signal was split after a transformerless mike preamp and fed directly into the Sony and dbx line inputs. For playback monitoring, we used a pair of AR-9s powered by a pair of db Systems amps (strapped for mono, 225 W per channel into 4 ohms, 20 Hz-20 kHz).

For both of us, the most striking aural impression was how good these processors sound compared to analog equipment. The clarity they achieve is well beyond the capabilities of analog recorders. Digital recording is truly a new level of performance, rather than an evolutionary improvement within an old technology.

Finding meaningful differences between the sound quality of Sony and the dbx was difficult. One way to describe their sonic characters is that the Sony is "bright" and the dbx is "dark." But that's not quite accurate because the difference doesn't lie in frequency content or tailoring.

Another description is that the dbx sounds like a tube amplifier, while the Sony sounds like a solid state amplifier. High violins seem a bit edgy on the Sony, but they have a feeling of air or spaciousness on the dbx. This isn't the same as hall ambience, since both machines perform well in that respect.

Perhaps the cause of this difference in sound quality is the 700's compander. It may add a small amount of distortion or noise modulation, which very slightly rounds off the sharp edges of the waveforms and gives an impression of

mellowness. Tube amplifiers often give the same psychological effect. Analog tape recorders do the same because of the gradual effects of distortion as the tape begins to saturate.

Another explanation for what we heard is the dbx's higher sampling rate and its simpler anti-aliasing filter. A higher sampling rate (644 kHz as opposed to 44.1 kHz) might capture more phase information, resulting in the impression of a more open, relaxed sound quality. Consider the difficult signal the recorder must cope with, and the higher sampling rate makes sense. For instance, an entire violin section playing in unison creates a complex tangle of similar waveforms slightly out of phase with each other. A recorder that resolves all that finely-detailed phase information might sound more realistic.

The CPDM system uses a lower-order anti-aliasing filter with a gentler cutoff slope than PCM devices require, so less frequency-dependent phase shifting occurs. The dbx has a -3 dB slope at 30 kHz, whereas the F1 drops like a stone above 20 kHz. This may contribute to the impression of a more relaxed and open sound on the dbx 700.

Using the 700

The designers obviously were experienced recordists who gave close attention to the human engineering of the 700. All the right kinds of controls and indicators, which a recording engineer needs in order to get the most out of the 700's extended dynamic range, are on the front panel.

The input and output controls are nicely thought-out. A toggle switch selects one of three settings: REFERENCE, TRIM, or ADJUSTABLE. REF is the standard, fixed level. When both input and output are set to REF, you have unity gain and optimum s/n ratio. No matter what changes you make, you can return to the standard setup quickly and easily just by flipping these toggle switches.

TRIM gives you a preset level, which you can adjust ± 10 dB with a trimmer pot on the front panel to give an alternative standard level. This is especially good for interfacing with a studio system. The trimmer must be adjusted by a screwdriver, so it can't be changed accidentally.

Finally, the freely adjustable variable pot lets you make any temporary setting you want. With the toggle switch, you can move back and forth from one position to another and always return to the exact setting.

Both the input and output sections

have a pair of clip lights. You can see at a glance when clipping is occurring; you'll know exactly where in the signal path it is taking place; and you'll cure the problem at the trouble spot easily. The first light-emitting diode (LED) shows pre-distortion, the other shows post-distortion.

The pre LED on the input section lights up when the input circuitry of the 700 is being driven at too high a level. To take care of this problem, you must cut the level *before* it enters the dbx.

On the output side, the pre LED shows that clipping that occurs prior to the output pot. The post LEDs in both the input and output stages show clipping immediately after the pot, and its setting will have an effect on that problem.

Since noisy mike preamps can be quite noticeable in a system with such a wide dynamic range, dbx developed suitably quiet (optional) mike preamps, with built-in phantom powering, for the 700. The gain range is variable in 10 dB steps from 20 to 60 dB.

Digital recording is truly a new level of performance, rather than an evolutionary improvement within an old technology.

Expanded Meters

The meters are the most attractive aspect of the 700's user interface. Normal VU and PPM meters, designed for analog recorders, indicate only the upper 25-30 dB of the dynamic range and are woefully inadequate for digital recording. So dbx developed a new meter with an expanded range and faster response. A toggle switch selects one of three different scales. During a demonstration at the Boston chapter of the Audio Engineering Society, many people asked if dbx planned to sell its meters separately, which is a nice compliment to their functionality.

On the recording scale, the LEDs are scaled in 2 dB increments from -40 to +20 dB. Below zero, they glow amber; above zero, they glow red. This particular scale is weighted to accommodate the dbx 700's pre-emphasis and com-

panding circuits. In an earlier version, dbx had a scale with the Stevens equal loudness contours (an interesting feature for measuring psycho-acoustic dynamic range), but replaced that with an expanded scale for calibration purposes, which might be more useful for the recording engineer.

The way to use these meters, according to dbx, is to keep the average level between 0 and +10. But if the program material is full of transient peaks, you may need to cut the level to keep the maximum at about +16. Whenever the signal goes over the +20 mark, you'll have gross distortion on your recording because digital circuits don't have a gradually increasing distortion curve, as do analog circuits.

Engineers experienced with analog recorders must change their approach to putting a signal on the tape. These meters help make the operator aware of the extended dynamic range and the absolute necessity of allowing enough headroom to avoid clipping. The analog medium leads the operator to record a bit on the "hot" side. This is because the trade-off of less noise is preferable to the slightly increased distortion and loss of highs that result from small amounts of tape saturation. In digital recording, when the signal exceeds the maximum level, the distortion is grossly obvious.

To monitor playback levels, set the meter switch to Signal Level. In this position, the meters have a range from -100 to +20 dB in 4 dB increments. Since they read unweighted rms values and have an extra 10 dB beyond the 700's range, they are uncompromisingly honest. They can reveal thermal noise in your recording setup, room noises, hum, traces of RF, outside traffic, and even the 700's own internal noise. All of these are nearly inaudible to the human ear because of its insensitivity to weak low-frequency sounds.

The calibration position gives a range from -10 to +5 in one-half dB increments and is unweighted. This position is useful for setting levels and balances. A 1 kHz tone at 0 on this scale will read about +12 on the (weighted) recording scale because of the pre-emphasis and compression.

Video Deck Interface

An important difference between the Sony PCM-F1 and the dbx 700 is the way they format the audio signal into the video frame. Both machines break the continuous stream of digital audio data into short segments and interleave

(alternate) these segments as they put them into NTSC format and then onto tape. This helps the error-correction circuits when dropouts occur. Sending a burst of good data between bursts of non-data gives the circuits a better chance to restore missing bits.

Sony goes a step further by interleaving the data across more than one video frame, while dbx does not. As a result, the Sony is more resistant to dropouts. But you can't edit its tapes with a simple (inexpensive) video editor because the interleaving will create strange noises at the edit points. However, for a machine intended for the home market, that is a reasonable trade-off.

To edit tapes made on the PCM-F1, you must transfer them to the Sony 1610. The 1610 uses wider (three-quarter-inch) tape to ameliorate the dropout problem and doesn't spread the data across frames. The PCM-F1 mutes for about two seconds [in its Mute On position] when uncorrectable dropouts occur, but the dbx 700 (or the Sony 1610) will let some rather objectionable noises through.

Since the dbx 700 was designed for the small studio and location recording market, rather than for the home recordist, it works best with U-matic video decks (although it works quite successfully with a VHS or Beta deck). An LED at the extreme right of the front panel indicates when a dropout occurs. During our tests, dropouts occurred about once every three to four seconds (on a Sony Beta Hi-Fi deck at BII speed). In the copy mode the 700 has no error correction, as does the F1, so you can make only about three generations of copies before errors from dropouts become a problem.

With any of these digital audio processors, you should use the video deck in the "PCM" or "Data" position for better dropout protection. Turn off the Beta Hi-Fi circuit, if the deck has that feature, because the pilot tone causes beat frequencies that create crackling noises when playing back on a deck without Beta Hi-Fi. This may apply to VHS Hi-Fi also, but neither of us has had experience with such a deck.

An interesting benefit of using video-cassettes is that one relatively compact tape provides two hours of recording time. At a typical concert, you could turn the recorder on at the beginning, and turn it off at the end, without worrying about shutting it off for applause and intermissions. By comparison, a 10½-inch reel of 1½-mm tape running at 15 ips lasts only 30 minutes. You

must worry about changing tapes between selections and about selections lasting longer than your reel of tape.

Limitations of the 700

Among professional users, four criticisms of the dbx 700 are being made. One is the lack of a service manual. Most home users don't need or want the service manual. But a professional in the middle of a recording session must have this information when things go wrong.

The most striking aural impression was how good the dbx 700 and Sony PCM-F1 sound compared to analog equipment.

For instance, the circuit cards are loaded with trim pots, but dbx supplies no information on how to adjust them. A skilled engineer always wants to optimize his equipment for a particular application, and without the service manual and the schematic, he can't do this. Perhaps dbx is still working on a manual, since the unit is so new to the market.

The second criticism is that the editing capability is fine for assembling a series of musical selections on a tape destined for the cutting lab, but the resolution is only one (video) frame: one-thirtieth of a second. This is equivalent to one-half inch of analog tape at 15 ips. It doesn't permit the kind of finely detailed editing that recording engineers are accustomed to doing. When a CPDM editing machine with finer resolution is available, this won't be a problem.

The third criticism is the use of a compander in the circuit. No matter how well it tracks, it still causes small amounts of phase shift, noise, and distortion. Some engineers object to the use of a compander; others don't mind. As we noted above, these effects may be responsible for the subjective sound of the 700. Whether this is good or bad is for the individual user to judge for himself.

The last criticism is the incompatibili-

ty of the CPDM system with the CD system. One solution is to develop a transcoder to convert the 700's signal to the CD format. This may or may not turn out to be a viable solution, since designing such a transcoder seems to be extremely difficult.

The other solution is to convert the CPDM signal back to analog, then reconvert it to the CD's PCM system, with a 44.1 sampling rate and 16-bit quantization. Purists would object to the extra analog stage and conversions. For the present, no one knows whether a transcoder would cause more problems than the extra digital to analog (D/A) and analog to digital (A/D) conversion, since no practical transcoder exists.

Minor Criticisms

The poor s/n at high frequencies is a problem. On the other hand, the information to be recorded consists entirely of upper partials, which are weak to begin with. If they're weak, they shouldn't be masked with noise. It's a tricky problem that no doubt will be debated endlessly.

The meter switch on the front panel is attached to the circuit card, and it simply protrudes through the front panel, rather than being anchored to it. For home use this would be acceptable, but for professional use—where the unit will be transported frequently—it isn't a good construction practice.

Conclusion

Choosing between these two digital audio processors isn't an easy task. They use two different methods of encoding and are intended for two different kinds of users.

Along with the obvious consideration of which device has the better sound quality, questions of editing capabilities, compatibility with other equipment, serviceability, and price all enter into the decision-making process. For the home user, the balanced line inputs and outputs and the XLR connectors present interfacing problems.

Perhaps the most interesting application involves CDs made from dbx 700 tapes—and a few will be available in the near future. How they will sound is difficult to predict, but the evaluation process will be fun. Those living in the Boston area who have heard the WGBH live broadcasts of the Boston Symphony and Pops concerts have had a taste of the dbx sound, and the response seems to be quite favorable. Keep your mind and your ears open as listening opportunities become available. □

How to Record Digitally—At Home

by Marc Wielage

It's not yet possible for consumers to record music on a "blank" Compact Disc, but that doesn't rule out home digital recording. With digital tape, a PCM digital adapter, and a videocassette recorder, you can record digitally—at home.

The wind-up watch...the horse and buggy...the fountain pen...and now, analog recording.

What do these things have in common? There's a good chance all of them will be as extinct as the dodo before the end of the decade. For better or worse, that's the price of progress.

Digital Adapters: Price Breakthrough

And so it is today with audio recorders, now that several firms are trumpeting the advent of low-cost PCM (pulse code modulation) digital audio adapters. This equipment breakthrough puts studio-quality sound equipment into consumers' hands at a fraction of the cost of more conventional pro audio gear—or at least, so say the manufacturers' ads.

But is digital an honest-to-gosh improvement—or a mere pretender to analog's throne? What advantages and drawbacks do digital recorders pose to the semiprofessional or serious amateur recordist? And what about the noisy rumblings from the audiophiles who believe that digital recording may be more of a disaster than a breakthrough?

Before we delve into these questions, one thing seems clear: Any recordist worth his salt should take extra care these days in selecting an audio recorder, whether it's for home or semiprofessional use.

Here's the good news: With a few exceptions, any analog recorder in the \$1000-and-up price range may be in serious danger of extinction, now that low-cost PCM audio adapters have hit the market. These add-on devices are capable of providing the best sound you've ever heard—and you won't have to mortgage your house to afford one.

The Pros of Digital

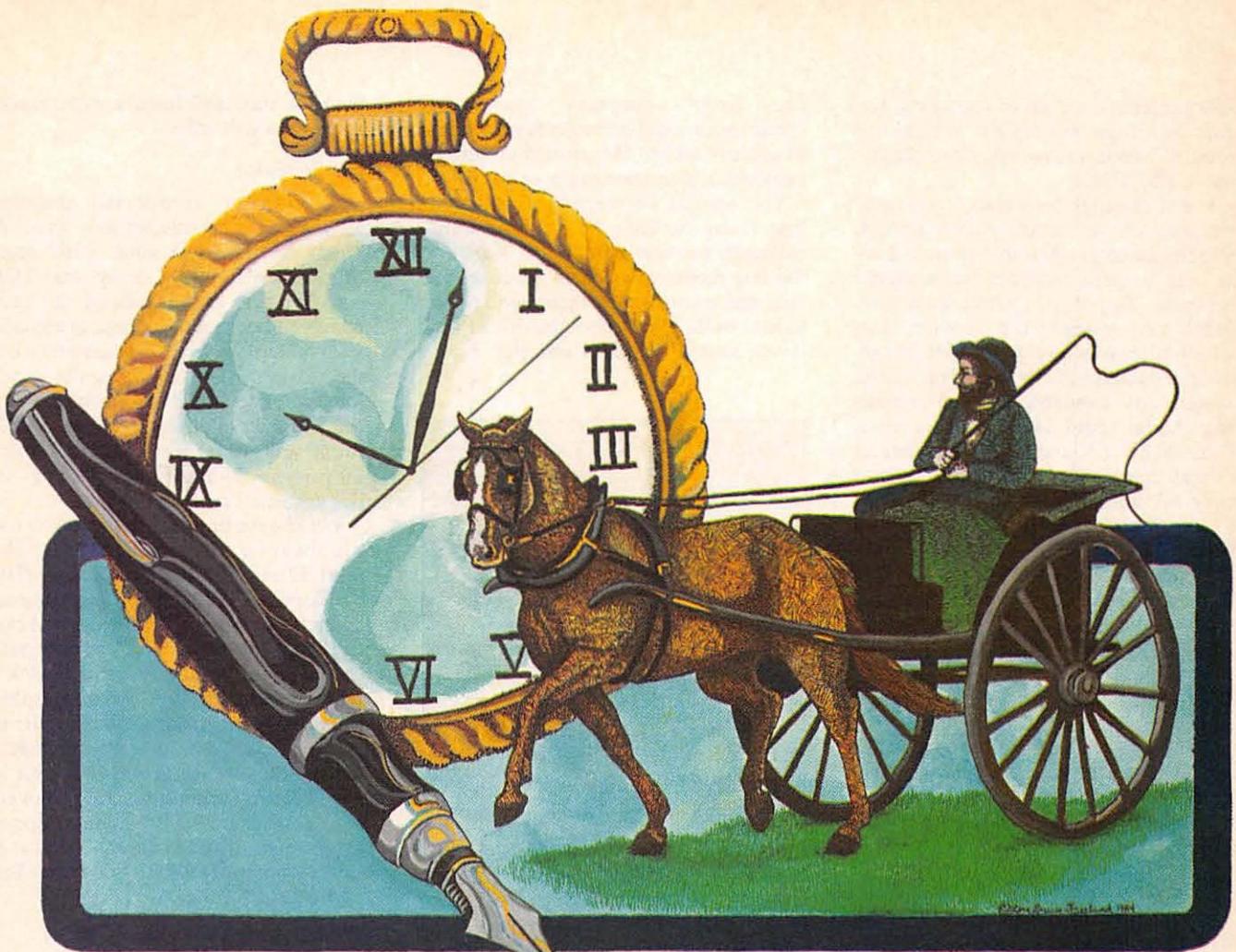
The advantages of digital recording

are numerous. Since all PCM adapters are designed to be used with conventional consumer-type videocassette recorders (VCRs), the tapes are easier to handle and probably will last much longer than a comparable open reel or audio cassette.

Digital tape costs are extremely low, now that the mass market success of VCRs has lowered the price of two-hour Beta and VHS cassettes to below \$6 in most areas. This compares favorably to open reel, which costs roughly \$5 per hour for 7½-inch recording (double that for 15-inch studio recording), and premium type-IV, metal audio cassettes at \$3 per hour.

The advent of low-cost PCM digital audio adapters puts studio-quality sound equipment into consumers' hands at a fraction of the cost of more conventional pro audio gear...

Videocassettes also are easy to store. Both Beta and VHS cassettes are smaller than an average paperback book, so they fit neatly on a shelf. It's easier to index and locate particular segments on a digital audio videocassette than on most conventional audio recorders, since many top-of-the-line VCRs are equipped with an electronic tape-time counter and can shuttle two hours of



Analog recording may soon be joining the wind-up watch, the fountain pen, and the horse and buggy in the annals of extinction.

tape in well under three minutes (for Beta VCRs).

Perhaps the biggest advantage of digital audio is quality. Since the recorded information is digital, there's virtually no loss in multigeneration copying.

Technical experts for several major manufacturers claim that you can dub a single tape more than a dozen times (that is, you can copy a tape once, then copy the copy, then copy that copy, and so on—without adding any additional noise and hiss). While I haven't had the stamina to go that far, I haven't heard any degradation in the four or five generations I've dubbed in my own tests. Even that is a far cry from conventional analog recording, which builds up a hefty amount of tape hiss and distortion even when noise reduction is used every step of the way.

Shopping for Digital

All right, we've got you convinced. Now that you've decided digital audio is just what you need, you'll probably

rush over to your local dealer and put your hands on every PCM adapter in stock and weigh the advantages and disadvantages of each.

This is where you'll run into problem No. 1: Even in major metropolitan areas, it's tough to find stores that carry these adapters, mainly because of their limited availability and relatively high cost. You may have to do a little detective work and contact both the manufacturer and professional audio dealers to find out exactly where you can find digital audio equipment in your area.

Digital audio recorders don't come cheap. Five years ago, Sony introduced its original consumer PCM-1 audio adapter for less than \$5000. It was a large, bulky device the size of a 40-pound office typewriter, filled to the brim with discrete circuits.

It took several years, but eventually, by reducing the digital-to-analog (D/A) and analog-to-digital (A/D) converters to IC chips, Sony cut the size and cost of the PCM-1 by more than 50 percent.

The new device, the PCM-F1, weighs only about 6½ pounds but still costs a hefty \$1900. That may sound a little high (particularly when you combine it with a portable VCR, which adds another 6 to 8 pounds to the package) but it's not bad compared to, say, a professional Nagra 4.2S recorder, which costs more than \$5000 and weighs about 20 pounds (with batteries).

Other manufacturers have followed Sony by introducing similar PCM adapters, most of which sell in the neighborhood of \$1000. Even Sony has added a lower-cost adapter—the PCM-710ES—to its digital ES line. The PCM-710ES duplicates virtually all the features of the original model except for portability.

Once you have a digital encoder, you run into problem No. 2: You'll need a VCR to record and play back the digital audio signals. Why? Digital signals use a bandwidth roughly twice that of analog recorders—close to 45 kHz. The most readily available and least expen-

sive systems capable of recording signals this high are VCRs, which use rotating heads to process video signals up to 700 kHz.

If you're a high-tech electronics buff, chances are you already own a VCR, which can be pressed into double-duty as both a video recorder and a digital recorder. But if you don't own one, you'll have to make the decision as to which format to buy: Beta, VHS, three-quarter-inch, or the new 8mm portable system now available from companies like Kodak (and later on this year, General Electric and RCA). Each has its overall merits and disadvantages, and they all sell in the range of \$500 to \$1200. Some bare-bones models cost as little as \$300.

VHS has the plus of being available in more stores than the other three formats, and at least two manufacturers, Mobile Fidelity and Direct-to-Tape, sell a few prerecorded PCM titles on both Beta and VHS. The U-Matic format (three-quarter-inch) is the standard for professional two-channel digital recording. It offers greater editing ease and more features than the other formats, but its high cost puts it beyond the reach of most home recordists.

Rolling Your Own With Digital

If you have any experience making live recordings with analog audio recorders, you may be feeling some trepidation over Sony's advice to set record levels on the PCM-F1 to peak at around -15 on the LED meters, a sharp contrast to the conventional practice of peaking at 0 VU. Relax. This provides sufficient headroom that prevents unexpected peaks from exceeding the maximum limit of the system, resulting in noisy static-filled distortion. Most adapters on the market feature large warning lights to signify excessive peaks. As long as you follow the manufacturer's directions, you should be able to capture every subtle nuance of a recorded event (with proper microphone techniques, of course).

The meters found in digital adapters are generally quicker to respond, have more dynamic range, and therefore are more accurate than conventional VU meters used in most studio consoles and recorders, although some LEDs are a little difficult to read in direct sunlight.

Setting the levels takes a bit more time and precision than I'm used to. Once they're adjusted, don't touch those knobs. You'll need to restrain from "riding" gain—the standard practice with analog recorders. With digital, it's

not really necessary, since the headroom should be more than enough to capture all but the most thunderous explosions, jet engine roars, or gunshots.

You should be warned in advance that many portable VCRs don't automatically provide an "E-to-E" signal in the stop mode; you'll have to cue up the tape and leave it in the record and pause modes before you'll be able to set any levels on the outboard encoder.

Sony PCM-F1 Digital Audio Processor

Manufacturer's Specifications

Frequency Response: 10 Hz to 20 kHz, ± 0.5 dB

Dynamic Range: >86 dB (14 bit), >90 dB (16 bit)

Channel Separation: >80 dB

Total Harmonic Distortion:

<0.007% (14 bit), <0.005% (16 bit)

Sampling Rate: 44.1 kHz

Wow and Flutter: Beneath measurable limits

Quantization: 14- or 16-bit linear

Modulation System: PCM

Power Consumption: 17 W (dc)

Power Requirements: 120 V, 60

Hz (ac); rechargeable battery pack NP-1 (one-hour); car/boat battery cord DCC24008 (not included)

Dimensions: 4 $\frac{1}{4}$ " x 3 $\frac{3}{4}$ " x 12 $\frac{1}{8}$ "

Weight: 8 lbs., 13 oz.

Price: \$1900

Company Address: Sony Consumer Products, Sony Drive, Park Ridge, NJ 07656

Since the rotating video heads are grinding away at the tape during this idling procedure, you should avoid leaving the machine in pause longer than necessary. Most VCRs automatically drop out of pause after about five minutes as a safety measure, but you should avoid leaving the machine in pause for more than a minute. This reduces the risk of tape damage or increased dropouts, which can wreak havoc on the digital signals.

Luckily, almost all ac-operated tabletop VCRs do provide E-to-E without reverting to the pause mode. Unfortunately, no conventional half-inch VCRs have the luxury of instant off-tape monitoring. This means you won't know if your recording is good until you play it

back—a standard feature experienced recordists will miss.

No Surprise

To prevent unexpected surprises later, avoid using inexpensive "grade Z" videocassettes and stick with name brands like Fuji, 3M, Sony, and TDK. And for best results, spend the extra couple of bucks and get high-grade tape, which boasts fewer dropouts and a better exterior shell than regular tapes. While I haven't had any problems with thin, 15-micron, high-grade Beta-L 750s, most manufacturers advise using 20-micron L-5000s or T-120s for dependable results.

Whichever brand of cassette you use, it's always a good practice to record at least 30 seconds of silence (voice slate, or identify the tape) at the beginning, since this is where the majority of tape dropouts usually occur. Dropouts cause the error-correction circuitry to kick in and use data from one area to replace the missing bits from another. If the errors (dropouts) are more than the circuit can handle, the signal will disappear for a split second until the system recovers.

Another good way to avoid dropouts is to use your VCR's fastest speed at all times—generally BII for consumer Beta and SP for VHS.

Which Video Format is Best?

I find the Beta format offers several significant operational advantages over the others for semipro PCM recording. Sony's Beta VCRs keep the tape threaded up against the heads at all times, making recueing the tape for quick edits or playback a fairly easy task. VHS machines load and unload the tape every time you hit the stop button, which is frustrating when you need to find an exact segment. (Technics' \$3000 SV-100 features a built-in cueing dial that makes this process easier.)

Another plus for Beta is that all Sony consumer VCRs made in the last five years feature a rear-panel PCM switch that turns off the video noise reduction and dropout compensator circuits (unnecessary for digital audio use, since the PCM adapter has circuits of its own). The rear-panel switch also allows recording in the vertical blanking interval (the area just outside the top of the picture), using almost the entire video frame. This helps to improve the performance of these VCRs by a smidgen.

Some VCRs, such as RCA's VJT-700 and Sony's SL-2700, include an indexing feature that places an inaudible signal at the beginning of recorded seg-

ments to aid in locating them later on. These and several other high-end Beta decks also boast an exact hours/minutes/seconds tape-time readout, which is handy when you're not sure how much tape is left. While practically all VCRs will perform adequately with any PCM adapter, Sony's special features make it more convenient to use than other brands.

In general, table model ac-powered VCRs are a little more dependable than most portable models, since fewer trade-offs are made between size and performance. On the other hand, you'd be crazy to limit yourself to recording only when an ac socket is handy, especially if your PCM adapter can be battery-operated. As long as you stick with one of the better portables, you shouldn't have to compromise on features or picture quality.

Some of the half-inch portable VCRs I've evaluated for PCM use include Sony's SL-2000 (identical to Zenith's recently discontinued VR-9800), RCA's VJT-900, and Panasonic's PV-6600; table models include Sony's SL-2710, SL-5600, RCA's VJT-700, and Panasonic's PV-1720. Most of these decks contain special circuits for performing nearly glitch-free video edits—an absolute necessity for PCM recording.

The 8mm equipment is a question mark at the moment, since it is new on the market. On the plus side, these VCRs are extremely tiny, using cassettes only slightly larger than standard audio cassettes. At the moment, only combined 8mm camera/VCR units have been shown, but stand-alone VCRs should be available soon. (Based on the demonstrations I've seen, I don't believe that 8mm's overall video quality is quite equal to the best Beta and VHS VCRs, so I'd be reluctant to use it for digital recording at this time.)

The new "Hi-Fi" processes now available in both Beta and VHS offer excellent analog audio. Each uses an extra set of subcarriers to capture a left and right audio signal and records these carriers within the video track. While the audio performance of Beta and VHS Hi-Fi is exceptional, my experience indicates that both are very sensitive to dropouts and tape flaws, resulting in clearly audible distortion. Even though Beta and VHS Hi-Fi lack the error-protection of PCM audio, you could use these two extra tracks for rear-channel information (for the quad buffs among us) or for later mixdown to stereo.

On the other hand, Sansui's PC-X1 adapter has a special proprietary "tri-

code" technique designed to improve slow-speed performance. While Sansui officials were a little reluctant to elaborate on their sophisticated design, my guess is that the unit employs some kind of enhancement and improved dropout compensation circuitry to minimize errors.

Regardless, you're taking a big risk to use slower speeds for important recordings, although it's probably OK for dubbing from analog records or other less significant events. On the other hand, my experience is that having any more

than two hours of material on a single cassette makes it cumbersome to locate a specific segment; it's like trying to find a file in a messy, crowded file cabinet.

Part II...

Next month, we'll look at the problems of on-location digital recording. Microphone selection, editing techniques, and digital audio tape standards are other areas we'll investigate. □

Marc Wielage publishes Videofax Quarterly and writes for Video Review.

Stereophile

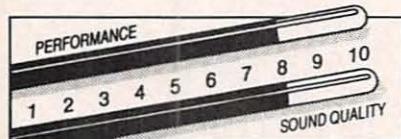
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Compact Disc-ussions



Classical



Mahler:
Symphony No. 9
Chicago Symphony Orchestra
Conductor: Georg Solti
Producer: James Mallinson
Engineer: James Lock
London 410 012-2 (DDD)

Mahler begins the *Ninth Symphony* with what seems the most cursory of musical ideas. But out of this "proto-music," an entire symphony evolves. And within 3½ minutes, Mahler brings you to an intense emotional peak.

Listening to the opening few bars is like watching the first large organic molecules swimming around in the primordial chowder, assembling and re-assembling until they combine in just the right way.

Almost inaudibly, the basses begin with a long note and a short note, both on the same pitch, followed by another long note in the horns. Mahler repeats the long-short-long motive, answering it with four pitches (la, do, re, do) with the rhythm inverted (short-long-short-long) in the harp's low range. The violas join in with a slow trill that is almost an accompaniment figure (the trill itself becomes thematic in the second and third movements).

But this time, the motive is answered by *cuvre* (stop-muted) horns playing sol, do, ti, fa, la. The rhythmic figure is inverted again and slightly altered with a dotted rhythm. Finally, the violins enter with the "sighing theme," which is constructed from the handful of ideas Mahler has just tossed out.

In less than 30 seconds, Mahler not only establishes his principal melodic and rhythmic ideas, but he starts to develop them. The effect is like watching an "instant" photo develop.

At Last...

I've described the first 30 seconds in such detail because you can *hear* all of it so clearly on Compact Disc. At last, Mahler's musical intentions are truly audible.

On an LP, the faint rumblings of the opening are hard to hear (no matter how loud you turn up the volume), because they are at the lowest edge of the dynamic range. Noise masks them so much the rhythm isn't apparent. If you can't hear and you don't recognize the significance of these opening gestures, you'll have difficulty understanding the musical development they portend for the next hour and a half.

As a demonstration of the CD's astonishing dynamic range, these opening primeval motives provide just the right baseline to measure the climax at 3:25. When you listen to this CD, adjust your volume so the beginning notes are just loud enough to hear, then take a few moments to let your ear adapt to silence. Push Play, and listen as Mahler unfolds his thoughts.

Slowly, and with consummate skill, Mahler leads you to that towering orchestral peak (at 3:25). On a CD you have nearly the same experience as you do in a concert hall. And that extreme contrast between loud and soft communicates, for the first time, Mahler's emotional message in a recording. You feel inundated with his spiritual ecstasy—feelings so intense they are nearly erotic.

That's what is wonderful about the CD medium—this transported spiritual ecstasy is the central concept of this symphony. Mahler's music expresses it beautifully; the CD lets that happen; and your musical, intellectual, and spiritual response is what Mahler wants it to be.

A Peak Experience

Listen to the way Mahler builds that initial climax, layer by layer. First, he gives you a secondary peak, which doesn't quite satisfy. But then he draws it out, extending and amplifying the excitement. As the music continues, it recedes, rebuilds, wavers, and finally soars over the top with a cascading downward arpeggio in the cellos, an intense crescendoing scream in the horns, and a piccolo shriek at the very top of the rollercoaster.

I compared this passage on the analog LP with the same one on the CD. The effect is excellent on the LP—but the CD goes much further and gets impossibly loud by the time the piccolo enters. On the LP, this passage must be compressed to avoid distortion. Thus the climax is disappointing, because you can't hear those beautifully terraced dynamic levels as Mahler builds tension and then releases it.

Another telling passage is at the very end of the first movement. Mahler winds down, fragmenting his themes back into their primordial motives. We rarely are aware of the gradual loss of highs on an LP as the stylus moves closer to the center of the record—it happens slowly, and the ear accepts it readily.

As I flipped the switch back and forth to compare LP and CD, however, I was appalled at how much high-frequency information the LP loses. It's particularly noticeable because the side is longer (30:10) than the optimum playing time for an LP (roughly 22:30). The upper partials of all the instruments are noticeably absent on the LP.

Also, after hearing the CD, the distortion at the end of the LP's first side is ugly. Listen as the harp slowly arpeggiates upward while a solo violin, horns, and an oboe play thematic fragments.

Finally, the harp, piccolo, and violins (using harmonics) play the last note. The percussive attack of the plucked harp string, mixed with the clear whistling of the violin harmonic, and the explosive puff of air when the piccolo player starts his note are impossible sounds to put at that place on an LP. And it shows.

The CD has no such problems. It reproduces beautifully that extraordinarily complex sound. Moreover, it could be at any point on the disc and sound equally good. Distortion and residual noise level are two of the LP's most serious shortcomings the CD has conquered.

Back to the Theme

After a long winding-down process, filled with trumpet fanfares and distant

sounds (primarily wind and percussion), Mahler brings back the theme. He sets it off with a warm, glowing polyphonic string introduction at 22:10, finally giving the theme to the cellos at 22:30.

Some conductors submerge that soaring cello melody, others (Bernstein and Walter) emphasize it. Solti follows a middle path and at least allows it to sing, but I yearn for a more intense color from the cellos.

Later, at 23:09, the trombones play the same motive, and the dissonant friction of the third note against Mahler's very complex harmonies is beautiful.



Georg Solti of the Chicago Symphony Orchestra

Just prior to the recapitulation, you can hear some church bells and gongs against the "marching" figure in the basses and timpani. This is too much low-frequency information for the LP to handle. But on the CD, you can hear quite clearly the difference between the sounds of the timpani and the plucked strings.

Mahler plays tricks with this figure, sometimes letting the timpani and basses play it together, sometimes letting them get slightly out of synchronization before merging once again. With a few soft gong strokes underpinning all of this, the LP sounds like mush. The CD allows you to hear all this detail clearly.

A Test for Your Woofers

Having said all this, I can't spend much time on the rest of the disc. However, the second movement contains some wonderful troll-like growls for the bass clarinet, bassoon, and contrabassoon that are a delight to hear and should test your woofers. The demonic scherzo is full of violent contrasts between loud and soft, thick polyphony, and sparse solo textures.

Then comes that serenely glowing final movement, illuminated with rich, divided string polyphony. In it, Mahler quotes extensively from *The Song of the Earth*. The Chinese poems he set in the song cycle/symphony reflect his growing interest in Eastern mysticism. In a sense, the last movement, if not the entire *Ninth*, is an extended meditation on the nature of human existence. Bernstein describes it as a symphony of farewells.

Solti's interpretation is too classical for my taste. Although he brings an admirable clarity and precision to Mahler's symphony, he doesn't infuse the score with the emotional depths I like. Solti recreates Mahler's orchestral effects accurately but misses their content and significance. He delivers expertly crafted sound but never goes quite far enough with the emotional aspects of Mahler to satisfy me. For Wagner, he is wonderful; for Mahler, he is too restrained.

This new Solti digital recording is especially good among his Mahler recordings, and it slowly won me over in LP form before I heard the CD. It also won Grammy Awards for Best Classical Album and Best Orchestral Recording of 1984.

The CD's acoustic perspective didn't seem quite right until I discovered the correct point of view. Remembering that mikes usually are hung overhead, I wondered what it would sound like if I were sitting where the mikes are. Then I noticed the reflections coming from the stage floor, bouncing off the rear wall and down at me from the ceiling.

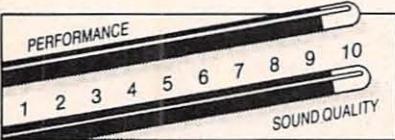
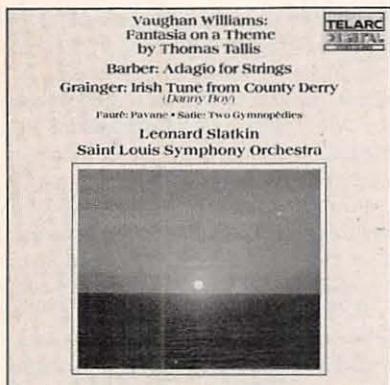
I realized I would be sitting in a balcony near the ceiling, looking down at the stage from a dizzying height, or suspended head down from a guy wire strung across the proscenium arch.

On the LP, you can hear enough ambience to imagine you're sitting in a good seat on the floor, but the CD is more honest. This only points out that mike placement is one of the most serious adjustments producers will have to make when recording for CDs.

Spiritual Character

The Mahler *Ninth* is an extraordinarily intense piece of music. It has wrapped around my life in some curious ways, and always carries with it memories of special times, people, and places. Its spiritual character has an effect on me that few other pieces of music are able to evoke. This recording is especially welcome at the beginning of the CD era.

Steve Birchall
Digital Audio Staff



Ralph Vaughan Williams:
Fantasia on a Theme of Thomas
Tallis

Samuel Barber:
Adagio for Strings

Percy Grainger:
Irish Tune from County Derry

Gabriel Faure:
Pavane, Op. 50

Eric Satie:
Two Gymnopédies (Orchestrated
by Claude Debussy)

St. Louis Symphony Orchestra
Conductor: Leonard Slatkin
Producer: Robert Woods
Engineer: Jack Renner
Telarc CD 80059 (DDD)

This program of beautiful pieces for string orchestra should permanently lay to rest the notion that the digital process makes string instruments sound harsh or otherwise unnatural.

The sound is bright and clear, and not at all forced or harsh. The mixing is closer than, say, Nimbus would make it but by no means claustrophobic. The

stereo image is good, and the solo instruments in the *Tallis Fantasia* are unrealistically highlighted. Obviously, great pains were taken.

The choice and layout of musical selections for this recording show imagination and taste. The pieces come from disparate sources—Vaughan Williams' reworking of a 16th century English hymn, Grainger's setting of a tune known here as "Danny Boy," Barber's 20th century elegy, and Satie's neoclassical miniatures—but they fit together well as a program. The collection progresses nicely from the grandeur of the *Tallis Fantasia* to the intimacy of the Satie *Gymnopédies* to the brooding nobility of the Barber *Adagio*, and so on.

The release is actually a compilation of those pieces for which each composer is probably best known. On the basis of beauty and accessibility, it is a disc I would recommend to a beginning listener of classical music. By accessibility I am referring to what computer people call "user-friendly"—not too difficult to grasp, but rewarding nonetheless.

For my money, the strongest performances on the disc are Vaughan Williams' *Fantasia* and Barber's *Adagio*. And Grainger's *Irish Tune from County Derry* is heartwarming. The other pieces are charming, but they don't make you sit up and take notice.

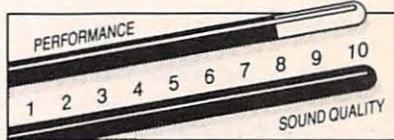
Debussy's orchestration of Satie's piano pieces (Satie invented the word *Gymnopédie*, which I believe means "music to teach children gymnastics by") is too fussy, with percussion effects and harp arpeggios. Debussy obscures the angular severity and stoicism essential to Satie. (A few years ago Windham Hill released an absolutely magnificent recording of Satie's piano music played by Bill Quist. It should be released on Compact Disc. How about it, Windham Hill?)

For those wishing to hear other works by these composers, Vaughan Williams' *Symphony No. 5* and Barber's *Violin Concerto* are good places to start. Neither however, is currently available on CD.

The string players of the St. Louis Symphony play with enviable ensemble and a lush, warm tone. Leonard Slatkin's stature as a conductor grows with each new Telarc disc.

As usual, the Telarc liner notes are lucid, informative, and set in a readable typeface (no phony trilingualism here), and the artwork and graphics are first-rate.

John Marks
Providence, RI



Mozart:
Violin Concertos Nos. 4 (D Major,
K. 218) and 5 (A Major, K. 219)
Oscar Shumsky/
Scottish Chamber Orchestra
Conductor: Yan Pascal Tortelier
Nimbus CD NIM 5009

This Compact Disc is exceptional in so many ways that I'm almost at a loss as to where to begin. Violinist Oscar Shumsky plays with a warm, vibrant tone, superb technique, and elegant musicianship.

Despite Shumsky's many commendable qualities and the high regard in which he is held by professional musicians and connoisseurs of violin playing, he has never received the widespread public recognition given to many lesser exponents of his instrument. Perhaps this digital recording, on the independent English audiophile label Nimbus, will to some degree change that.

Shumsky, born in 1917 in Philadelphia, was one of the last pupils of the great Leopold Auer, the teacher of Jascha Heifetz, Mischa Elman, and Nathan Milstein. Shumsky brings that heritage and a wealth of musical experience to this effort, having been first violinist in the Primrose String Quartet and a violinist in the NBC Orchestra under Toscanini.

His current activities include conducting, teaching, and playing the viola, as well as the violin.

These performances reveal a musician of strong conviction and individual style. It's Nimbus' policy to edit performances as little as possible, so Shumsky must have a dependable as well as formidable technique.

Certain stylistic touches (such as the downward slides in the violin's opening phrase in the slow movement of the D Major concerto) may seem a bit heavily mannered to listeners accustomed to the antiseptic playing of the post-Heifetz generation of virtuosi, but they are in keeping with the intimate and mellow approach of Tortelier, himself a violinist, and the Scottish Chamber Orchestra.

These performances do not display the architectural perfection of Heifetz' nor the wit of Perlman's, but in their own way they are thoroughly convincing.

The entire recording conveys a feeling of respect and affection for music and musicians alike. I look forward to hearing more from the Scottish Chamber Orchestra.

The recorded sound is the other exceptional quality of this CD. Recorded at Queens Hall, Edinburgh, the sound is unusually alive and natural. The session engineers have placed all of the instruments in realistic stereo perspective, without undue emphasis on the solo violin—a natural balance especially rewarding during passages in the violin's lower register. The blend with supporting strings approaches perfection.

There is not only a sense of air—of space around the instruments—but also of hall acoustics and room boundaries. Especially impressive is the hall reverberation at the end of each movement.

For those wishing to compare this CD to earlier analog recordings, I recommend the following LPs:

- K. 218; David Oistrakh, violinist, with the Philadelphia Symphony Orchestra; Eugene Ormandy, conductor. Columbia MG 33328 (mono).
- K. 218; Anne-Sophie Mutter, violinist, with the Philharmonia Orchestra; Riccardo Muti, conductor. Angel DS 37904.
- K. 219; David Oistrakh, violinist, with the Staatskapelle Dresden; Franz Konwitschny, conductor. Deutsche Grammophon 2726 087.

All in all, even if *Violin Concertos Nos. 4 and 5* is not your cup of tea, I recommend this CD as an example of the potential of the medium when so much musical and technical talent is committed.

While these performances will not

replace David Oistrakh's 1955 monophonic LPs as my reference recordings, and though Anne-Sophie Mutter plays with more sparkle, I keep playing this CD, and it holds up well.

What's more, the recorded sound is the closest to "concert hall" I have heard yet.

(Author's note: This import CD is available from Serenade Record Shop, 1713 G St. N.W., Washington, DC 20006.)

John Marks
Providence, RI



Brahms:
Four Ballades, Op. 10
Piano Sonata in A minor, D. 537
 Arturo Benedetti Michelangeli
 Producer: Cord Garben
 Engineer: Klaus Hiemann
 Deutsche Grammophon 400 043-2

The more you know about the piano, piano playing, and the difficulties of recording the piano, the more you will be impressed by this magnificent Compact Disc. If your equipment and listening room are up to the task, the realism of this recording will astonish you.

The LP version of these two performances is excellent, but even on fine turntable systems there is still a sense of strain and compression. In contrast, the CD lacks all extraneous noise and allows



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those "little sounds" of a live performance to emerge—hammer sounds, breathing, foot movements, and all.

Even though the piano used for this recording was more than 60 years old, it has an absolutely silent action and marvelous bloom on the tone. The recorded sound is focused and full, but not so closely miked that it makes you feel claustrophobic.

What makes this CD really stand out, however, is the repertory and performance. Arturo Benedetti Michelangeli has a reputation for Glen Gould-like eccentricity, but you wouldn't know it from his piano playing, which is refined, controlled, and above all, elegant.

These are aristocratic readings. Michelangeli's technical equipment and musical gifts are such that he can let the music speak for itself, which is the paradox of a great interpretation.

While Brahms is known to concertgoers mostly for the strength of his symphonies and concertos, he began and ended his creative life with works for the solo piano.

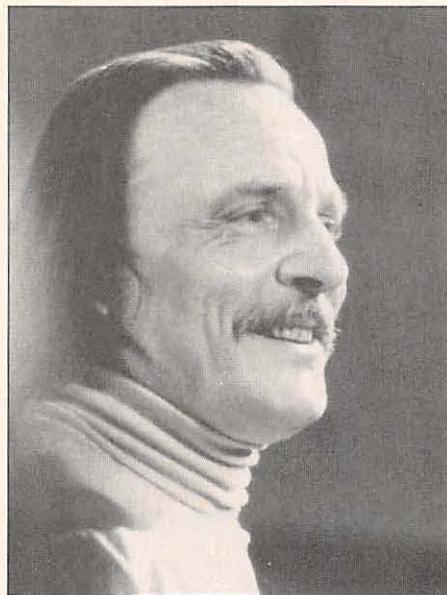
The *Four Ballades* presented here is an early work (Op. 10), but the music is not at all immature. Brahms had a hard early life, and Schumann's advocacy of young Brahms was probably a mixed blessing. Brahms was torn between his feelings for Clara Schumann and loyalty to his mentor, by then in a mental institution. This shows in the music. Michelangeli's interpretation, especially of number four, is simply riveting.

The Schubert piece is another matter entirely. Although young Schubert had his share of romantic troubles, it doesn't seem he brooded over them while writing the a minor sonata. The problems he grappled with were entirely musical, and this work, again from the composer's early period, reveals a confident and adventurous intelligence.

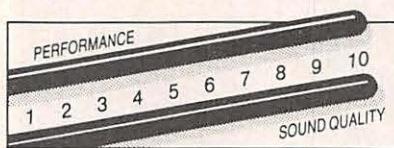
The demands this sonata makes upon the pianist are significant, and Michelangeli is equal to them. His technique is impressive. His staccato style and his legato phrasing of chords must be heard to be believed, especially in the slow movement.

This is not a coupling or an interpretation I would have gone out of my way to acquire, but now I wonder how I lived without this CD. All involved are to be congratulated. For my money, this is the best piano CD so far.

John Marks
Providence, RI



Michelangeli: Standout performance.



Dvorak:
Serenade, Op. 22
Notturno, Op. 22
Waldesruhe (Silent Woods) for
Cello and Orchestra, Op. 68
Los Angeles Chamber Orchestra
Conductor: Gerard Schwarz
Producers: Marc Aubort, Joanna
Nickrenz, Amelia Haygood
Engineer: Marc Aubort
Delos D/D 3011 (DDD)

This is one of the most delightful Compact Discs to come along so far. If you don't like it, you probably just don't like music—it's as simple as that. The recording is superb and the playing is lovely, especially Douglas Davis' eloquent cello in *Waldesruhe*.

Dvorak's Op. 22 *Serenade* has been well-represented in recordings, including von Karajan on CD, but this performance is a standout even in such gifted company. The naturalness and warmth of phrasing and tone give an almost Elgarian sense of repose and tranquility tinged with regret.

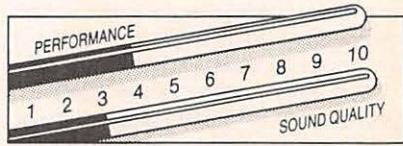
The real discovery on this disc, at least for me, is the *Waldesruhe* (Silent Woods).

It's similar to Faure's *Elegie* for cello and orchestra, not only in feeling but in structure as well.

Douglas Davis, the cello soloist, was a student of Piatigorsky and is principal cellist of the Los Angeles Chamber Orchestra. He plays with faultless intonation, effortless technique, and nobility of spirit.

The recording places the chamber orchestra and soloist in a natural balance with good depth and hall ambience. Not a trace of harshness mars the warm and full sound.

John Marks
Providence, RI



Gustav Holst
The Planets, Op. 32
Berlin Philharmonic
RIAS Chamber Orchestra
Conductor: Herbert von Karajan
Chorus Master: Uwe Gronostay
Producer: Gunther Breest
Recording Supervision: Michel Glotz
Recording Engineer: Gunther Hermanns
Deutsche Grammophon 400 028-2
(DDD)

While both the LP and Compact Disc version of *The Planets* have been enthusiastically received by some, I have been trying hard to warm up to this CD, and I just can't.

The Planets is well-represented in the recording field. In my mind, the competition has the better of this CD. That

is not to recommend Maazel's CD, produced by CBS, which is even more forgettable.

For one thing, this CD just doesn't sound like stereo. Compare the stereo image from a Telarc CD with what we have here. This recording is more reminiscent of a multi-track popular album.

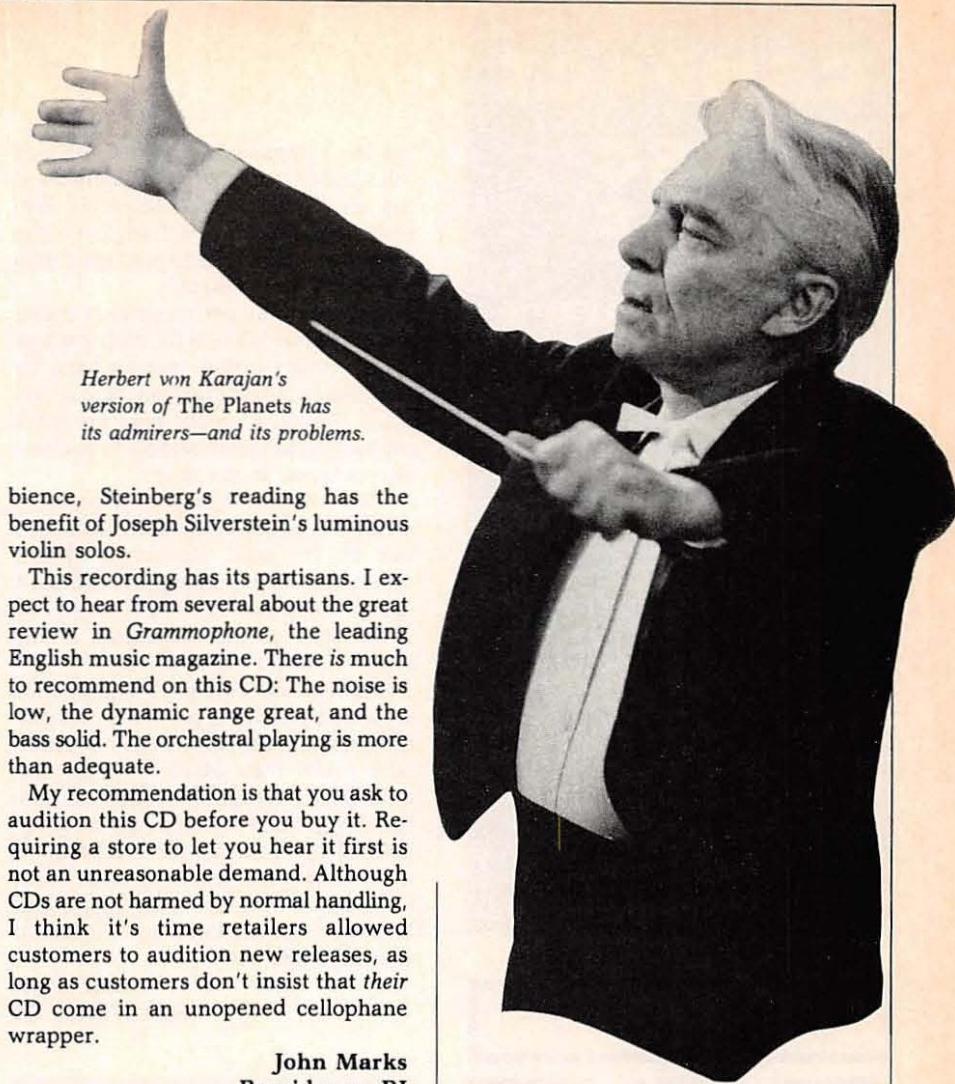
Furthermore, due to close miking, there is little sense of hall acoustics. Again, compare this recording to a Nimbus CD and learn what this one lacks. The whole effect is vaguely disorienting.

Part of the problem could be Berlin's Philharmonic Hall; perhaps natural, simply miked recordings are impossible in that location.

The other problem is the interpretation: a combination of a literal reading with fussy dynamics and tempos. Certain touches, such as highlighting the organ flourishes in the Uranus section, just don't sit well with me. I am not sure that this music should be taken as seriously as it is here.

Gustav Holst was an English composer, not a German one. Yet, there is a sense of rigidity about this performance that is distinctly German, not English.

I prefer a lighter hand wielding a broader brush for this music. My recommendation is William Steinberg's effort with the Boston Symphony (DG 2530 102 on LP). Not only does Boston's Symphony Hall provide better acoustic am-



Herbert von Karajan's version of *The Planets* has its admirers—and its problems.

bience, Steinberg's reading has the benefit of Joseph Silverstein's luminous violin solos.

This recording has its partisans. I expect to hear from several about the great review in *Gramophone*, the leading English music magazine. There is much to recommend on this CD: The noise is low, the dynamic range great, and the bass solid. The orchestral playing is more than adequate.

My recommendation is that you ask to audition this CD before you buy it. Requiring a store to let you hear it first is not an unreasonable demand. Although CDs are not harmed by normal handling, I think it's time retailers allowed customers to audition new releases, as long as customers don't insist that their CD come in an unopened cellophane wrapper.

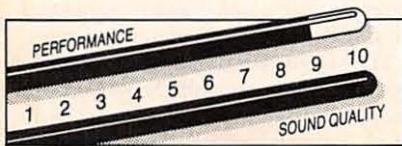
John Marks
Providence, RI

PART ONE

MAHLER
Symphony No. 2 in C, "Resurrection"

LEONARD SLATKIN
SAINT LOUIS SYMPHONY ORCHESTRA & CHORUS
Kathleen Battle, Soprano
Maureen Forrester, Contralto

TELARC



**Gustav Mahler:
Symphony No. 2 in C,
"Resurrection"**

Producer: Robert Woods
Engineer: John Renner
Telarc 80081/82 (DDD)

The first release of a familiar work on a new medium usually receives special scrutiny—and, often, negative criticism. The technology is sometimes not yet fully ripe, as was the case with many of the rather dismal quadraphonic recordings released in the mid '70s.

Even when a new technology has been mastered, the first few recordings are likely to be of lower quality. In contrast, this recording of Mahler's *Resurrection* symphony is revolutionary, partly because the Compact Disc medium preserves the excitement of the original performance and partly because the performance itself is so glorious.

Leonard Slatkin and his St. Louis forces finally have been given a chance to demonstrate why *Time* magazine recently rated the St. Louis Symphony one of the top 10 orchestras in the country. Their performance is bold, strong, and spiritual.

The technical perfection of Telarc's microphone technique allows you to hear this Mahler symphony with unprecedented clarity. Every pianissimo is couched in velvety silence. Every climax is as overpowering as Mahler intended.

The stereo panorama is so well-defined that you can pinpoint the exact location of each solo instrument, while the balance between the vocal soloists and the orchestra is perfect.

And what soloists! Kathleen Battle's hauntingly ethereal "Urlicht" (Primeval Light) solo in the fourth movement sets the stage for the finale, during which both Maureen Forrester and the St. Louis chorus shine.

The chorus' pianissimo entrance (disc 2, 2:20:00) makes it possible to believe, as the program notes point out, that dur-

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ing the symphony's first performance "the audience gasped at the moment of the choral entrance." Later, as Forrester's voice floats effortlessly out of the chorus, the impulse is to gasp again, this time with pure delight.

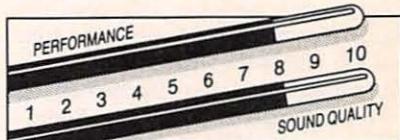
The rest of the performance is equally impressive. Witness the daring splash of the violins in the opening bars, introducing a bitingly sarcastic first movement. Slatkin's tempos here are more majestic than usual, adding to the tension inherent in the music.

The middle movements are properly reflective, lighthearted, and dance-like. But in the final movement Slatkin unleashes the full strength of Mahler's titanic emotions. The word "resurrection" takes on new meanings as the music climaxes in the finale.

Although this Telarc CD is a superior recording in every respect, the performance may not appeal to all tastes. Those who prefer their Mahler smooth and solemn may not approve of all this vitality and vigor. But no one should be disappointed by the technical excellence of the recording. These are two discs worth listening to over and over again; and because they are CDs, there's no fear of wearing them out.

Earl Allen
Fort Worth, TX

**Kiri te Kanawa/
English Chamber Orchestra**
Conductor: Jeffrey Tate
Producer: Paul Meyers
Engineer: John Dunkerly
London 410 004-2 (DDD)



**Frederica von Stade/
Royal Philharmonic Orchestra**
Conductor: Antonio de Almeida
Producer: David Mottley
Engineer: Peter Brown
CBS MK 37299 (DDD)

Marie-Joseph Canteloube de Malaret studied under Vincent d'Indy at the end of the 19th century. Both composers came from the Auvergne region of rural France, and they shared an interest in the language and folk songs of their native province. D'Indy's *Symphony on a French Mountain Air* is an example of his use of Auvergnat folk themes.

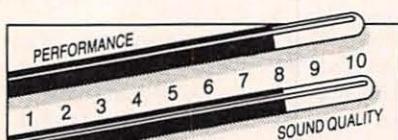
The language of the Auvergne, called Languedoc, is a lovely language for singing. It contains Arabic influences, and it sounds similar to Portuguese.

Canteloube not only collected these folk songs, but he also provided alternative lyrics in French and composed orchestral settings for concert performance. These settings were immediately and immensely popular, because they display unpretentious melodic beauty and an inspired use of the orchestra.

Songs of the Auvergne have been well-preserved on recordings since the 1920s. Madeleine Grey's pre-World War II 78 rpm discs, which many historians consider definitive, capture the folk song element. Anna Moffo's and Victoria de los Angeles' LPs are still available and are treasurable.

Of the two performances on Compact Disc, sung by Kiri te Kanawa and Frederica von Stade, I recommend that you buy either—or both. The two CDs, excerpts from a rather large compilation, do not entirely duplicate each other.

The sumptuous orchestral settings on both CDs are ravishingly played and recorded. The dynamic range and variety of orchestral color will give even the



**Canteloube:
Songs of the Auvergne**

best systems a complete workout; both recordings are of demonstration quality. And the wind and double reed players in both orchestras are to be commended for their arabesque-like playing.

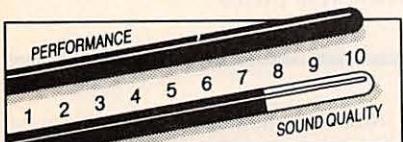
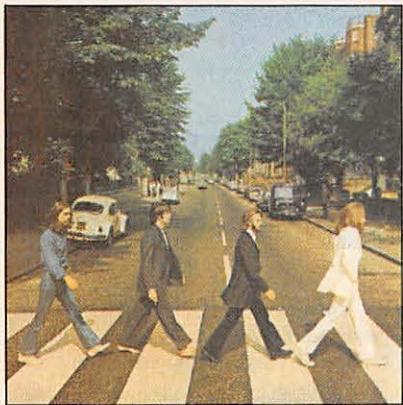
Canteloube, wanting to be true to the folk music form, did not graft intellectual sophistication into the songs. Though the settings of the songs are simple, they are evocative, atmospheric, and a pleasure to hear.

In particular, both performances of *La Delaissado* shimmer in the heat of a still mid-afternoon summer landscape. This music is seductive.

Of the two lovely young singers, te Kanawa sings with more clarity and poise, but I prefer the girlish naturalness of von Stade for this sort of music.

John Marks
Providence, RI

Pop/Rock



The Beatles:
Abbey Road
Producer: George Martin
Engineers: Geoff Emerick and Philip McDonald
EMI/Odeon CP-35-3016 (AAD)

When *Abbey Road* was first released—in September 1969—critics and Beatles fans alike heralded the album as a land-

mark in rock music. Now, 15 years later, the album still stands as a shining light in a sea of mud, holding up surprisingly well in these times of new wave, old wave, disco—excuse me—dance music, and synthesized drums.

Having the Beatles on Compact Disc is a natural idea, particularly for the serious rock collector interested in preserving these songs far beyond the limitations of conventional LPs. Not that the CD version of *Abbey Road* is perfect. . . . On the Japanese import of this classic, some noticeable audible hiss shows up, and it's particularly irritating during low-level passages.

As an early multitrack production from the pre-Dolby era, *Abbey Road* probably represents the state of the art of that time, although I can't help but wonder just how many analog generations the master tape went through before a copy was made available for digital mastering. The overall equalization seems adequate, without the shrill RIAA-analog equalization mistakenly used for a few previous Japanese CD pressings.

Curiously, someone back in the mastering lab took great pains in editing out the hiss between most of the songs on the first side, creating a well of absolute



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silence between the cuts. I found this a little disconcerting, but had no problem with the eight-song medley on the second side, which runs continuously from "You Never Give Me Your Money" to "The End."

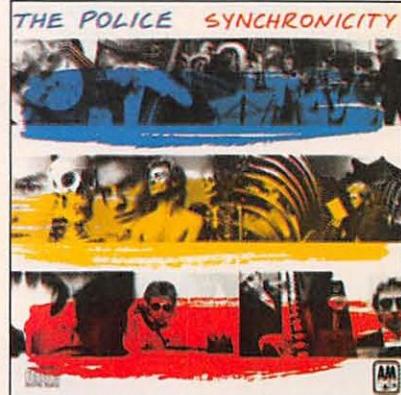
In addition, I'm having trouble getting used to the break between "I Want You (She's So Heavy)" and "Here Comes The Sun"; I'm used to turning the LP over at that point. Along those lines, you'll find it easy to cue each individual song using the player's track search feature—a big plus for the digital disc format.

Aside from the few aforementioned nit-picks, I found *Abbey Road* a joy to listen to in every other way, with profound depth and clarity beyond the standard U.S. pressing and even the costly Mobile Fidelity audiophile release. Subtle nuances like fingers sliding past guitar frets and Ringo Starr's sharp-edge cymbals take on new life, as do Paul McCartney's excellent bass lines. And John Lennon's vocals never sounded better. This was also the first Beatles album to showcase George Harrison's talents with the then-new Moog synthesizer, which shows up

on "Maxwell's Silver Hammer" and "Because."

Let's hope that once Capitol and EMI release *Abbey Road* and other Beatles albums on CD in the U.S., they'll take greater pains to use the true master tapes for CD mastering—something even Mobile Fidelity was unable to do with the \$350 deluxe "Limited Edition" boxed Beatles set.

Marc Wielage
Los Angeles, CA



The Police: *Synchronicity*

Producers: Hugh Padgham and

The Police

Engineer: Hugh Padgham

A&M 3735 (ADD)

After two albums of energetic new wave/reggae music, followed by two albums of politically charged "world music," singer/songwriter Sting and The Police have created an intensely personal and introspective work: *Synchronicity*.

The political orientation is still present, but the focus is inward. The result is a more subdued and refined sound—a far cry from the exuberance of earlier releases. The production reflects this material; it isn't as lively and immediate.

Co-producers Hugh Padgham and The Police have added strings and keyboards



Synchronicity is well-suited for CD. Copeland, Summers, and Sting are flawless.

where sparse arrangements once predominated. The Compact Disc format is well-suited to this change, allowing the subtleties of such songs as "Every Breath You Take" to be realized fully.

That song and "Synchronicity II" are the centerpieces of this disc. Both are about betrayal, and both are powerful. "Every Breath You Take" is a personalized account of a shattered relationship. The metronomic drumming ticks off the minutes as the singer relentlessly pursues his former lover. Over a driving rhythm, the biting guitar of "Synchron-

icity II" echoes the oppression of modern life and the tension created by the overlapping of private and public conflicts.

"Walking in Your Footsteps," on the other hand, exposes a simplistic viewpoint that undermines the sophisticated image The Police try to project. It is an interesting idea, contrasting the sound of the African finger piano with technorock and the fate of the dinosaurs with nuclear annihilation. The CD's clarity enhances the spaciousness of the jungle setting. Sting evokes the image of an an-

thropologist searching for traces of early man, but the lyrics stretch the dinosaur analogy to the breaking point.

"Murder by Numbers," not found on the LP version of *Synchronicity*, stands out as an obvious "B side" single. It's laudable to include more program material on the longer format CD, but this is a lightweight tune.

And "Mother," Andy Summers' attempt at comic relief, is the best reason I have heard for programmable players with track-skipping capability.

One aspect of this disc cannot be faulted: the outstanding playing of the musicians. Stewart Copeland is one of the finest drummers in rock music. His crisp attacks and accents are placed well forward in the mix and benefit from the added sharpness of the CD format. Sting's sinewy bass and Summers' agile guitar complete the sound of this remarkably cohesive unit.

The sound quality on *Synchronicity* is nearly flawless. This is among the better examples of an analog recording transferred to CD. It has been digitally remixed to accommodate the special conditions of CD playback. The highs are sharp without being shrill, and tape hiss has been reduced to nearly inaudible levels.

A&M has obviously made an effort to produce a quality product. As a result, *Synchronicity* is a "best buy" among the current crop of analog-transfer CDs.

Ken White
Digital Audio Staff

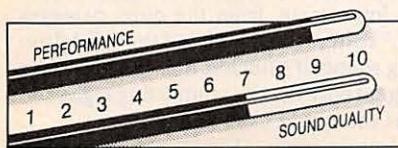


Joan Armatrading:

The Key

Producers: Steve Lillywhite and Val Garay

Engineers: Mark Dearnly and Val Garay
A&M CD-4912 (AAD)



Two of my friends regard Joan Armatrading as their heroine. One is a male law student at a traditional southern university, the other is a working mother of three teenagers. Armatrading's appeal to such a diverse audience is a tribute to her universality. Her lyrics strike a common personal chord, while her music is varied enough to encompass a broad spectrum of listeners.

Still, with the exception of "Show Some Emotion," radio airplay and wide-

spread exposure have eluded her. *The Key* represents a straightforward bid to reach a larger market.

The Key is the second recording Steve Lillywhite has produced for Armatrading. Lillywhite has worked with U2, Marshall Crenshaw, and numerous other rockers. His trademark sound of thunderous drums and prominent guitars would seem at odds with a woman whose first album was based squarely in the folk idiom. Surprisingly, the combination works. Armatrading has an ability to distill various influences, yet preserve her unique sound.

I was anxious to hear how Lillywhite's production values would translate to the digital format. Perhaps the biggest improvement is the added expansiveness, which also accounts for the greater sonic impact. Lillywhite isn't known for his

subtlety or large dynamic range; every instrument is up front. So, although the available range isn't utilized, the added clarity of the CD enhances the detail. And detail is Armatrading's forte.

As a writer of finely crafted tunes, Armatrading has come under fire for "I Love It When You Call Me Names," a song about sado-masochistic relationships. She has passed it off as an attempt at humor, but it's a curious track to lead off a disc. While the rest of *The Key* (as well as her other albums) is sensitive and intelligent, this song sounds like a Stones throwaway.

The Key follows the pattern of Armatrading's last release, *Walk Under Ladders*, combining brief, catchy tunes with imaginative production and instrumentation. Although none of the musicians are credited in the notes, the basic sound compares to *Walk Under Ladders*, but leans toward mainstream.

Many of these songs could have been hits, but only "Drop the Pilot" (one of two songs produced and engineered by Val Garay) received (limited) airplay. "Foolish Pride," one of the best songs Armatrading has recorded, features terrific guitar and punchy horns. "Bad Habits" is funny, funky, and perfect video material. Unfortunately, a black woman playing rock music isn't likely



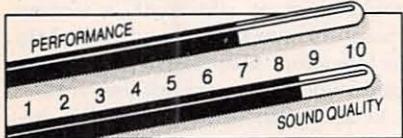
Joan Armatrading strikes a common personal chord with *The Key*.

to fit into any of the rigid categories of American top 40 radio.

Generally, A & M has done a fine job of transferring analog masters to CD, and *The Key* is no exception. The sound is crisp and clean, although the upper midrange is overemphasized. This gives the disc—particularly Armatrading's vocals,

a somewhat harsh quality. The bass, slightly muffled on the LP, is improved on the CD. Overall, both Lillywhite and Armatrading survive the translation to CD quite well.

Ken White
Digital Audio Staff



Electric Light Orchestra: *Secret Messages*

Producer: Jeff Lynne
Engineer: Bill Bottrell
Jet/CBS Records ZK-38490 (AAD)

The Electric Light Orchestra may be no more, what with their break-up last fall, but the group's songs live on. And what better way to play an ELO recording than on a beam of light?

Group leader Jeff Lynne went all-out in coming up with his most confusing, obtuse lyrics so far—camouflaged with gimmicky kitchen sink production featuring everything from synthesized drums to melletronish dog barks.

More curiously, nearly every track contains backward phrases (the ones referred to in the album's title) guaranteed to have you asking: "What the hell was that?" The messages seem to be tongue-in-cheek jokes Lynne used partially in response to critics and partially as a bow to the Beatles (particularly "Rain" and "Revolution No. 9"). Of course, unless you own a professional model CD player, you'll have a real tough time getting this (or any) digital disc to play backward.

Aside from the backward messages, Lynne throws in a number of references to previous ELO songs. For example, the title track contains the phrase "from Out of the Blue," and "Bluebird" emphasizes

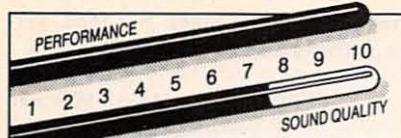
Lynne's fascination with the color blue (he's written songs in the past called "Mr. Blue Sky" and "Midnight Blue," among others). "Four Little Diamonds" is essentially a sequel to "Sweet Talkin' Woman," where he's still "searchin' for that woman" (though now with a more psychotic bent), and "Rock'n'Roll Is King" mentions "rolling over Beethoven," echoing ELO's breakthrough single from 1973.

Sadly, all of these thin parlor tricks don't quite cover up what is basically a creatively empty album, lacking most of the pop sensitivity Lynne exhibited on *Time and Discovery* and lacking the creativity of ELO's *Out of the Blue*, *Face the Music*, and *El Dorado*. Soundwise, though, this is one of the cleaner sounding analog CDs I've heard, with the background noise level ducked down to almost nil. The dynamic range is equally impressive, from the quiet passages of "Letter from Spain" to the hard-driving sound of "Rock'n'Roll Is King." The digital edge fits the scintillating highs and gut-thumping bass to a T.

Interestingly, *Secret Messages* was

(Continued on p. 78.)

Third Stream



An Evening With Windham Hill Live

Personnel: George Winston, Alex deGrassi, William Ackerman, Michael Hedges, Liz Story, Darol Anger, Chuck Greenberg
Producers: William Ackerman, Alex deGrassi, and Steven Miller
Engineer: Steven Miller
Windham Hill WD-1026 (AAD)

William Ackerman founded Windham Hill as a company dedicated to quality. The label has produced consistently outstanding analog albums, and its success is based on an appreciation of excellence in recording and performance.

But it is somewhat disappointing to listen to the Compact Disc rendering of *An Evening With Windham Hill Live*. The analog master fails to measure up to the exacting standards of the digital format. This is especially apparent in comparison with direct-to-digital discs.

Though the CD retains the warmth of the analog version, tape hiss, which the listener would subconsciously filter in predigital days, becomes intrusive. Also, the edges aren't as sharp as we've become accustomed to in these spoiled times. Therefore, be forewarned: This disc may not meet your expectations for a Windham Hill product. (Windham Hill reports that all new releases will be digitally recorded.)

That caveat aside, *Windham Hill Live* is a wonderful offering. The analog recording techniques are superb. The piano is clear and full, and the guitars have a terrific presence.

The musicians are equal to the challenge. Individually and collectively, Windham Hill is a group of captivating writers and performers. Known primarily as musicians of choice for the post-hippie, Volvos-and-brie set, they present albums with a serious and self-conscious image. It's a relief to hear bits of humor scattered through the introductions on this disc.

In the ensemble mode, none of the musicians' egos predominates. The degree of integration and harmony is remarkable.

The solo performances are equally praiseworthy. Alex deGrassi stands out, both for his deft technique and sensitive compositions.

Although the styles, instruments, and combinations differ, a common thread runs through this recording (as well as the entire Windham Hill catalog). The compositions seem to revolve around a center of peace. The music is uniformly contemplative, although not complacent.

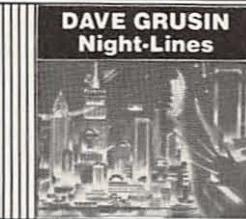
"Hawk Circle," performed by Ackerman and Michael Hedges on guitar and George Winston on piano, exemplifies this idea. Soothing, but with an undercurrent of tension, the piece begins with a repeating guitar figure. A piano and second guitar interplay weave in and around and eventually draw the first guitar into the improvisation. The music builds to a climax, then falls away into silence, followed by a restatement of the original guitar line. It is circular, like much of the Windham Hill music.

If you're not yet acquainted with this label, this disc or the *Windham Hill Sampler* (WD1024) would be an excellent introduction. For now, *An Evening with Windham Hill Live* is highly recommended for fans and newcomers alike.

Ken White
Digital Audio Staff

JAZZ ON CD

GRP



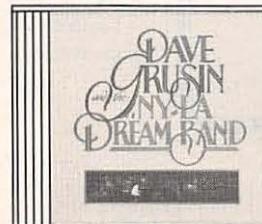
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(Continued from p. 76)

rumored to have been, originally, a double album, but CBS chose to keep it at a standard length—probably because ELO's popularity peaked about five years ago.

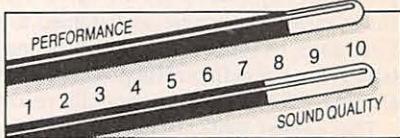
Another note of interest: The CD version of *Secret Messages* features a track not found on the LP release: "Time After Time," a strange, slightly paranoid tune possibly inspired by the Nicholas Meyer Jack the Ripper film.

Aside from offering what sounds like a demo for the Eventide Digital Harmonizer (featuring Lynne singing in triple and quadruple harmony with quasi-female versions of himself!), "Time After Time" is essentially a quick four-minute pop/new wave throwaway that ends with what could be either an apocalyptic explosion or a rocket take-off. It's easily the weakest track on the nearly 47-minute recording, and I'm not surprised it was omitted from the LP. Still, a freebie is a freebie.

I found it amusing that Jet/CBS didn't acknowledge inclusion of a "bonus"

track in the liner notes. But then, perhaps that's a secret message in itself.

Marc Wielage
Los Angeles, CA



Culture Club:
Kissing To Be Clever
Producer/Engineer: Steve Levine
Virgin CDV 2232 (AAD)

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George O'Dowd, a.k.a. Boy George, is Culture Club's leader and visual symbol. With rock videos being an important method of exposure today, the Boy has ventured before the camera for a half-dozen musical appearances. But if Boy George's appearance is a turnoff, do yourself a favor and ignore it. Listen to *Kissing To Be Clever* and you'll understand why Culture Club is more than a vehicle for the Boy's cross-dressing. There's some fine music here.

Culture Club started out playing old Motown songs and other pop music favorites. They were not the most musically proficient band, but they had an ability to take apart these tunes and, with the pieces, build new ones. Culture Club openly admits to plagiarism, but it's imitation as the sincerest form of flattery. The band, along with Boy George on vocals, consists of drummer John Moss, guitarist Roy Hay, and Michael Craig on bass. They write songs as a group effort. The songs range from the bass- and

drum-dominated "White Boy," "Take Control," and "Boy, Boy, (I'm the Boy)" to the reggae-inspired "I'll Tumble 4 Ya" and "Love Twist." "Do You Really Want To Hurt Me," the song that put Culture Club on the map, is a Motown-style masterpiece. Vocal perfection is combined with a lazy but clean bass line, competent percussion, and excellent production.

I compared this CD to the U.S. album (Virgin FE 38398). It follows the order of songs on the British release, which flows better than the U.S. release. Unfortunately, the CD omits the chart-topping "Time (Clock of the Heart)," one of the finer moments of the U.S. release. An attractive booklet is provided with the CD, including complete lyrics.

Although the LP features superb arrangement and production, it suffers from a muted sound. Percussion is somewhat dull and the bass is muddy. On the CD, some obvious remixing and equalization changes appear, but the changes are not entirely positive. Overall, it's an improvement over the analog pressing, but it could have benefitted from a little more care.

A negative aspect of the CD is the reduction of the low bass impact. The bass sound is tighter and cleaner, but lacks the punch found on the LP. Songs that suffer a considerable loss in this area include "I'll Tumble 4 Ya," "White Boy," and "White Boys Can't Control It." In each of these tunes the lifeless bass is transformed into a sound that's too tight and not at all fluid. It sounds as if the strings of the bass guitar are being snapped.

Fortunately, what is overdone on some songs is corrected on others. On "Love Twist" the change in bass is less radical and it works. You can almost feel the strings, but without the aforementioned snap. "I'm Afraid of Me" and "Do You Really Want To Hurt Me" also show marked improvement on the CD.

The vinyl version of *Kissing To Be Clever* is marred by blurred percussion and occasionally muffled vocals. The CD offers some positive changes in vocal and percussive reproduction, and a cleaner, crisper sound is achieved on most songs (although on a few there is some shrillness). "You Know I'm Not Crazy" and "Boy, Boy, (I'm the Boy)" are particularly harsh-sounding on CD, but still better than the overly dull LP.

Lyrically, Culture Club deals with that age-old subject of love, as well as some heavier topics. One recurring theme revolves around the concept of the "White Boy." This is not a theme of race, but

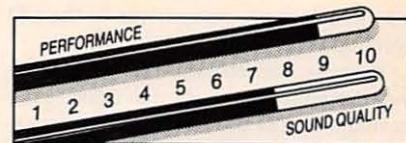


Boy George and Co.: Moss, Craig, and Hay.

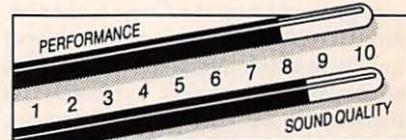
rather of people as clones. The "White Boy" is like his parents, and his children will be like him; the world passes by all of them.

As Culture Club matures, they will rise to even greater heights than *Kissing To Be Clever*, but this is definitely a shining first effort. The CD, while suffering from some overzealousness in the transfer from the master tape, overall is much better than the album version. Improved dynamics, lower noise level, and cleaner definition prove to be a winning formula for most of the nine songs on the CD.

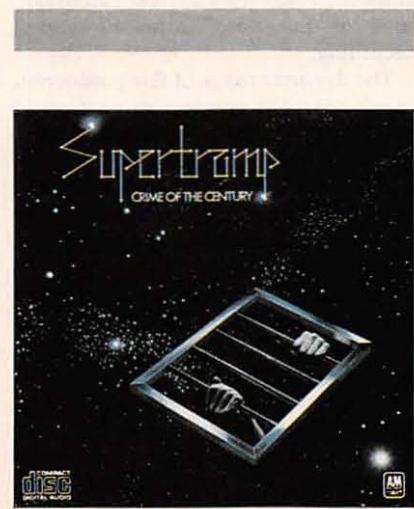
John Jordan
Taunton, MA



Supertramp:
Crime of the Century
Producers: Ken Scott and Supertramp
Engineers: Ken Scott and John Jansen
A&M CD-3647



Breakfast in America
Producers: Peter Henderson and
Supertramp
Engineer: Peter Henderson
A&M CD-3708



The British band Supertramp earned notoriety with the release of its 1974 LP *Crime of the Century*. The style varied from heavy-metal rock to light jazz, with a perfect fusion of all elements. The LP also was notable for its solid production and engineering. In 1979, the group reached its second and final peak with the release of *Breakfast in America*.

Both LPs were favorites among audio enthusiasts and popular music fans. In addition, half-speed versions of both albums were released, including a 5000-copy, limited-edition Ultra High Quality Record (UHQR) pressing of *Crime of the Century* from Mobile Fidelity Sound Labs. The half-speed analog pressings were far superior to the original releases, so they provide a much

more interesting comparison to the CD versions.

Because Supertramp uses an extended dynamic range in its music, the transfer to CD produces, in one sense, a negative effect. During quiet passages, the noise level of the analog master tape becomes apparent. This is especially obvious on *Crime of the Century*, where every song begins with a quiet passage, many in excess of one minute. Although the background hiss may be disconcerting, the CD is still an improvement over the half-speed LP, which has an equivalent or greater amount of noise.

Breakfast in America fares much better on both CD and half-speed, with only slightly more noise on the half-speed version. One interesting observation: The noise level on "Casual Conversations" is higher on the CD.

Equalization on the CDs is also a problem, especially with *Crime of the Century*. It seems the original master tape must have been pushed higher in the upper midrange to offset losses in this region during the analog pressing process. Because the CD is inherently flatter than an analog record, there is a need for this equalization to be changed.

In present form, the *Crime of the Century* CD is marred by a slightly harsh quality to guitar and piano, an edginess on vocals, and sizzling cymbals. The transfer to CD needs improvement, rather than the CD itself.

Breakfast in America received a much better CD transfer—or the master tape was superior. For whatever reason, the sound is smoother and better defined. "Child of Vision" is a particularly good example. The sound is less cluttered on the CD, with improvements in dynamics and upper and lower frequency ranges.

The best news about both of these CDs is the improvement in dynamic range. There is a new intensity in the louder passages and a cleaner and tighter overall sound. Bass, drums, and percussion are redefined, so the music rests on a more solid foundation. This improvement is particularly apparent on "School," "Just Another Nervous Wreck," "Gone Hollywood," and "Crime of the Century."

Musically, Supertramp fits in with the notable British bands Yes and Genesis. Hard-driving rock is counterbalanced with a fine mix of rhythms and "wall of sound" orchestration to form a well-placed, constantly changing aural landscape. The jazzy horns and piano on "Bloody Well Right" meld perfectly with the song's rock sounds. "Gone Holly-

wood" and "Casual Conversations" also exhibit a unique blending of sounds.

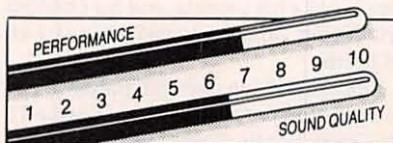
Supertramp understands pacing better than most rock bands. If your interest wanes at any point during either disc, wait a moment, and a hook will capture you again. When you're all tensed up by the dramatic conclusion of "School," the light piano introduction to "Bloody Well Right" will give you breathing space before the music sends you up to another peak.

If you are, as the title of one track suggests, "Just Another Nervous Wreck," you'll be soothed by the soft melody of "Casual Conversations." This jazzy tune is built around an electric piano and features one of the nicer horn arrangements found on either disc. The hiss mentioned previously is the only flaw on this song.

The hits are also here—the serious but fun tunes "The Logical Song" and "Take the Long Way Home." These songs are more thoughtful, intelligent, and more interesting than the usual popular fare.

The common thread throughout Supertramp's material is a theatrical approach. There are moments when you can hear a pin drop, while at other times there is all the intensity of thunder. Both *Breakfast in America* and *Crime of the Century* have a story to tell and the superior dynamics of the CD format make the experience more real. This advantage far outweighs any negative qualities that appear in the transfer from the master tapes.

John Jordan
Taunton, MA



Visage:

Visage

Producers: Visage, Midge Ure

Engineer: John Hudson

Polydor 800 029-2



Visage's (Steve) Strange leader.

Visage is one of the first new wave recordings to be released on Compact Disc. The choice surprises me because, although it's a fine album in many respects, Visage does not take full advantage of the possibilities of digital recording.

The dynamic range of this production is not nearly as spectacular as it could be, considering the 90 dB signal-to-noise ratio of a CD. It also does not have the biting high frequencies that CDs can deliver. The entire disc seems to be slightly muted with an overly dominant boomy bass.

Another reason I'm surprised that Visage was released on CD is that I don't think it's the group's best effort. Visage's second album, *The Anvil*, would have been a better choice.

Visage, however, does have its moments. In "Tar," Visage leader Steve Strange's depiction of the evils of cigarette addiction, and a compelling

melody, make it one of the best songs on the disc. "Moon Over Moscow" and "Blocks on Blocks" are perfect examples of Visage at its best. The drumbeat and synthesizer line that make these songs so danceable are the group's trademarks.

The most interesting track is "The Steps," an instrumental composition reminiscent of Bach's d minor *Toccata*.

There are a couple of clunkers, though, including "Malpaso Man." Its only merit is the drumming, which was mixed so loudly that it covers up some boring vocals.

Die-hard new wave fans with new CD players to try out will probably end up buying this release—if only because so few of its type are on the market.

Aaron Krehbiel
Buffalo, NY



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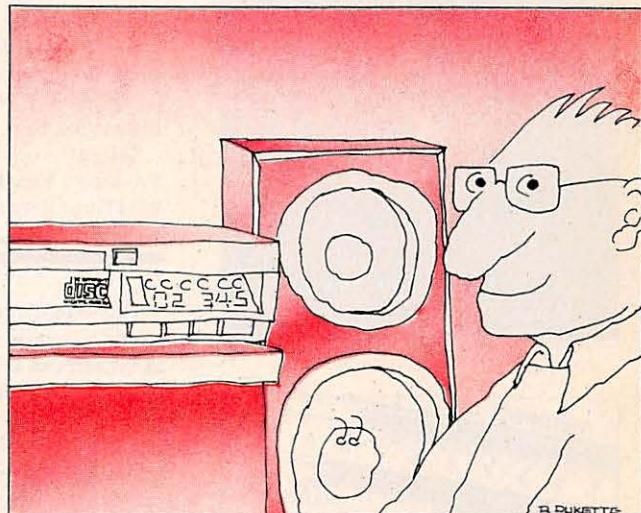
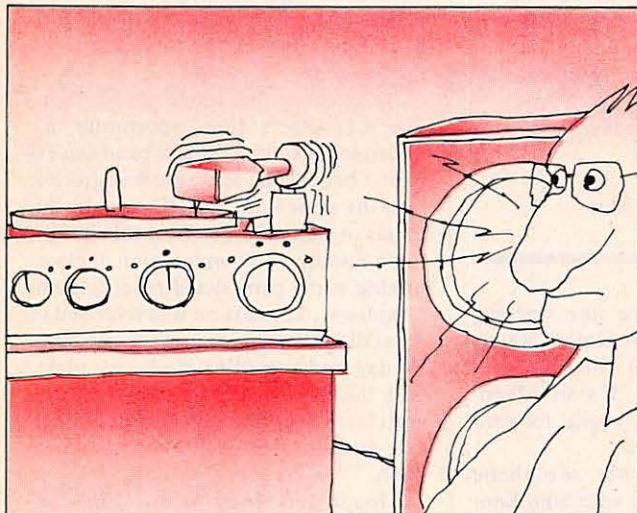
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Jazz



Burnin'

Don Menza and his '80s Big Band

Personnel: Don Menza—leader, arranger, tenor sax. Chuck Findley, Ron King ("Dizzyland" only), Don Rader, Bobby Shew, Frank Szabo—trumpets. Charlie Loper, Bill Moffett, Bill Reichenbach, Mayo Tiana—trombones. Dana Covelli, Gary Herbig, Jay Migliori ("Dizzyland" only), Jack Nimitz—reeds. Frank Strazzeri—piano. Frank de la Rosa—bass. Nick Ceroli—drums.

Engineers: Ken Kreisel and Scott Simon

Producer: Ken Kreisel
RealTime Records RT 3001

pression while maintaining the underlying mood of the piece.

"New Spanish Boots" reminds me a bit of Tom McIntosh's "November Afternoon" with a Latin feel. Strazzeri's "Relaxin'" boasts a comfortable melody and appropriate solos by Chuck Findley, Menza, and Strazzeri. "Tonawanda Fats" has more than a hint of Don Ellis' forward-looking band of the 1970s, with its shifting tempi and high-pressure reed section solo.

Technically, the sound is excellent. The CD offers the opportunity for dynamic contrast; a big jazz band can exploit it better than some musical groups.

At the same time, the CD contains little air or natural ambience; this is due, undoubtedly, to a combination of close-miking and a constricted recording environment. The session was recorded in a building that serves as an audio store by day and recording studio by night. Still, the RealTime folks should be congratulated for not over-sweetening the mix with artificial echo and reverberation.

I found the string bass a little flat-sounding at times and the piano a bit tinkly. This, too, suggests close-miking, although a lot of piano recordings I've heard recently have this sound; perhaps it's just a characteristic of some newer instruments.

On RealTime's analog pressing of this same session, there was a little dulling of the highs toward the end of "Dizzyland." The CD version, at first, gives the same impression. But on closer listening I realized that I was hearing the trumpet section bowing out and regrouping for a chorus of solo four-bar breaks at the end of the piece.

I also found that what I thought was a slightly distorted arco bass on parts of the LP is actually the bass trombone. Chalk up a couple of points for CD clarity.

So the first big band CD is, on the whole, a considerable success. The band is well-rehearsed and well-disciplined, the arrangements are first-rate, and the soloists are more than competent and obviously happy to be freed from the usual creative restrictions of studio work.

I'm sure it won't be long before CDs recorded by well-known bands—such as those directed by Count Basie, Woody Herman, or Buddy Rich—are released. But if you're a big band fan, there's no need to wait. This session by Menza and his cohorts will keep you happy now and in the future.

Tom Krehbiel
Buffalo, NY



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The CD's program notes describe Menza as a "self-taught" composer and arranger. While he may not have undergone formal training in those areas, it's clear that he has studied and learned from the works of major jazz and popular orchestra arrangers, from Duke Ellington to Henry Mancini.

Of the six works on the CD, Menza wrote and arranged four. The other two compositions, also arranged by Menza, are Duke Ellington's "Don't You Know" and Frank Strazzeri's "Relaxin'."

The CD's title tune, "Burnin'," is a fast, modern blues chart with solos by Joe Romano and Bobby Shew preceding a sax section chorus, Jack Nimitz's reeds, and Frank Strazzeri's piano. Scored solos by reed or brass sections seem to be a trademark of Menza's writing; they're usually ear-catching, and they're cleanly executed on this CD.

"Don't You Know I Care," Menza's feature for his own sax work, is one of the most rewarding tracks on the disc. An out-of-tempo, half-chorus piano introduction leads into Menza's lyrical solo statement of Ellington's theme. Menza's ad-lib choruses double the tempo and provide a stronger approach to lyrical ex-

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Placido Domingo: My Life For A Song
Echoes of Spain: Music of Albéniz/John Williams, guitar
Gershwin Live!: Sarah Vaughan/Los Angeles Philharmonic, Michael Tilson Thomas

MK 37794
MK 37779
MK 39002
MK 37278
MK 37813
MK 34509
MK 37251
MK 39024
MK 35883
MK 36711
MK 38868
MK 35867
MK 39059
MK 33233
MK 37800
MK 35850
MK 37299
MK 37814
MK 37832
MK 37799
MK 36679
MK 37277
MK 37786
MK 39310
MK 37846
MK 37796
MK 37249
MK 35848
MK 37792
M2K 37852
M2K 37273
M2K 38667
MK 37795
MK 37295

Mendelssohn: Concerto in e Minor for Violin & Orchestra, Op. 64/Beethoven: Two Romances/Isaac Stern, violin/Boston Symphony Orchestra, Seiji Ozawa

MK 37204

Mendelssohn: Violin Concerto in e Minor, Op. 64/Saint-Saens: Violin Concerto No. 3 in b Minor, Op. 61/Cho Liang Lin, violin/Philharmonia Orchestra, Michael Tilson Thomas

MK 39007

Mozart: Three Piano Concertos

MK 39222

Mozart: Murray Perahia, piano

MK 39224

Mozart: Piano Concerto No. 15 in B Flat Major, K. 450/Piano Concerto No. 16 in D Major, K. 451/English Chamber Orchestra, Murray Perahia, soloist & conductor

MK 37824

Mozart: Piano Concertos Nos. 17 & 18/Murray Perahia, piano & conductor/English Chamber Orchestra

MK 36686

Mozart: Symphony No. 40 in g Minor, K. 550/Symphony No. 41 in C Major, K. 551 (Jupiter)/Sinfonieorchester Des Bayerischen Rundfunks, Rafael Kubelik

MK 36703

Mozart: Violin Concertos Nos. 3 & 5/Pinchas Zukerman, violin & conductor, St. Paul Chamber Orchestra

MK 37290

Mussorgsky: Pictures at an Exhibition/Ravel: La Valse/New York Philharmonic, Zubin Mehta

MK 35165

Prokofiev: Symphony No. 5/Israel Philharmonic Orchestra, Leonard Bernstein

MK 35877

Rachmaninov: Piano Concerto No. 2 in c Minor, Op. 18/Rhapsody on a Theme of Paganini, Op. 43/Cecile Licad, piano/Chicago Symphony Orchestra, Claudio Abbado

MK 38672

Ravel: Bolero

MK 37289

Rodrigo: Concierto de Aranjuez & Fantasia para un Gentilhombre/John Williams, guitar/Philharmonia Orchestra, Louis Fremaux

MK 37848

Rodrigo/Villa-Lobos: Guitar Concertos/John Williams, guitar/English Chamber Orchestra, Daniel Barenboim

MK 33208

Schubert: Impromptus, Op. 90 and 142/Murray Perahia, piano

MK 37291

Shostakovich: Symphony No. 5/New York Philharmonic, Leonard Bernstein

MK 35854

Shostakovich: Cello Concerto No. 1 in E Flat Major, Op. 107/Kabalevsky: Cello Concerto No. 1 in g Minor, Op. 49/Yo-Yo Ma, cello/Philadelphia Orchestra, Eugene Ormandy

MK 37840

Isaac Stern 60th Anniversary Celebration: New York Philharmonic, Zubin Mehta

MK 36692

R. Strauss: Also Sprach Zarathustra/New York Philharmonic, Zubin Mehta

MK 35888

R. Strauss: Don Juan/Till Eulenspiegel/Death & Transfiguration/Cleveland Orchestra, Lorin Maazel

MK 35826

R. Strauss: Ein Heldenleben/Cleveland Orchestra, Lorin Maazel

MK 34566

R. Strauss: Ein Heldenleben/New York Philharmonic, Zubin Mehta

MK 37756

R. Strauss: Sonata in b Minor, Op. 5/Five Piano Pieces, Op. 3/Glenn Gould, piano

MK 38659

Stravinsky: Petrouchka/New York Philharmonic, Zubin Mehta

MK 35823

Stravinsky: Petrouchka (1947 version) Scherzo a la Russe/Philharmonia Orchestra, Michael Tilson Thomas

MK 37271

Stravinsky: The Rite of Spring/New York Philharmonic, Zubin Mehta

MK 34557

Tchaikovsky: 1812 Overture/Beethoven: Wellington's Victory/Vienna Philharmonic Orchestra, Lorin Maazel

MK 37252

Tchaikovsky: Piano Concerto No. 1/Erlin Giles, piano/New York Philharmonic, Zubin Mehta

MK 36660

Tchaikovsky: Symphony No. 5/Cleveland Orchestra, Lorin Maazel

MK 36700

Kiri Te Kanawa: Verdi & Puccini Arias/London Philharmonic Orchestra, John Pritchard

MK 37298

Tsutsumi: Dvorak

MK 39349

Vivaldi: The Four Seasons/Pinchas Zukerman, violin & conductor/St. Paul Chamber Orchestra

MK 36710

Vivaldi: The Four Seasons/Soloists from Orchestre National de France, Lorin Maazel, violin & conductor

MK 39008

Vollenweider: Caverna Gardens

MK 37827

Wagner: Arias

MK 38931

Wagner: Der Ring Des Nibelungen/New York Philharmonic, Zubin Mehta

MK 37795

Wagner: Overtures/Philharmonia Orchestra, Lorin Maazel

MK 36699

Wagner: Prelude & Liebestod (Tristan)/Dich Teure Halle (Tannhauser)/Immolation Scene (Die Gotterdamerung)

MK 37294

Montserrat Caballe/New York Philharmonic, Zubin Mehta

MK 37280

Yo-Yo Ma: Kreisler/Paganini Transcriptions for Cello/Patricia Zander, piano

MK 37280

Yo-Yo Ma: Cello Concertos

MK 35848

CBS Records

A Chorus Line: Original Cast Recording

CK 33581

Adam Ant: Strip

EK 39108

Jeff Beck: Blow By Blow

EK 33409

Jeff Beck: Wired

EK 33849

Liona Boyd: Tokyo

MK 39031

Boston: Don't Look Back

EK 35050

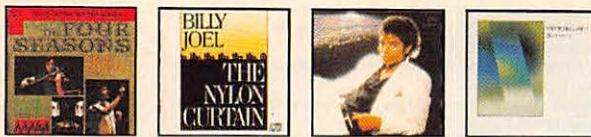
Brass In Berlin

MK 39035

Dave Brubeck: Time Out

CK 8192





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| Roseanne Cash: Seven Year Ache | CK 36965 |
| Cheap Trick: Budakan | EK 35795 |
| Elvis Costello: My Aim Is True | CK 35037 |
| Elvis Costello and the Attractions: Punch the Clock | CK 38897 |
| Culture Club: Kissing To Be Clever | CDV 2232 |
| Culture Club: Painting By Numbers | CDV 2285 |
| Charlie Daniels Band: Full Moon | EK 36571 |
| Miles Davis: Decoy | CK 38991 |
| Miles Davis: Kind of Blue Horn | CK 08163 |
| Miles Davis: Man With The Horn | CK 36790 |
| Miles Davis: Sketches of Spain | CK 08271 |
| Al DiMeola: Elegant Gypsy | CK 34461 |
| Al DiMeola: Friday Night | CK 37152 |
| Al DiMeola: Tour de Force-Live | CK 38373 |
| Placido Domingo: Perhaps Love | MK 37243 |
| George Duke: Dream On | EK 37532 |
| Bob Dylan: Greatest Hits | CK 09463 |
| Bob Dylan: Highway 61 Revisited | CK 09189 |
| Bob Dylan: Infidels | CK 38819 |
| Earth, Wind & Fire: Electric Universe | CK 38980 |
| Earth, Wind & Fire: Powerlight | CK 38367 |
| Earth, Wind & Fire: Raise | CK 37548 |
| Electric Light Orchestra: Discovery | ZK 35769 |
| Electric Light Orchestra: Secret Messages | ZK 38490 |
| Fastway: All Fired Up | CK 39737 |
| Dan Fogelberg: Greatest Hits | EK 38308 |
| Dan Fogelberg: Phoenix | EK 35634 |
| Dan Fogelberg: Souvenirs | EK 33137 |
| Dan Fogelberg: Windows and Walls | CK 39004 |
| Footloose: Original Soundtrack | CK 39242 |
| Phillip Glass: Photographer | MK 36241 |
| Eddy Grant: Killer on the Rampage | CK 38554 |
| Merle Haggard: Big City | EK 37593 |
| Merle Haggard/Willie Nelson: Pancho & Lefty | EK 37958 |
| Herbie Hancock: Future Shock | CK 38814 |
| Herbie Hancock: Headhunters | CK 32731 |
| Heart: Passion Works | EK 38800 |
| Julio Iglesias: El Amor | 35 8P19 |
| Julio Iglesias: Emociones | 35 8P18 |
| The Jacksons: Triumph | EK 36424 |
| Michael Jackson: Off The Wall | EK 35745 |
| Michael Jackson: Thriller | EK 38112 |
| Bob James/Earl Klugh: One On One | CK 36241 |
| Billy Joel: 52nd Street | CK 35609 |
| Billy Joel: Glass Houses | CK 36384 |
| Billy Joel: An Innocent Man | CK 38837 |
| Billy Joel: The Nylon Curtain | CK 38200 |
| Billy Joel: The Stranger | CK 34987 |
| Janis Joplin: Pearl | CK 30322 |
| Journey: Escape | CK 37408 |
| Journey: Frontiers | CK 38504 |
| Judas Priest: Defenders of the Faith | CK 39219 |
| Kansas: Point of Know Return | ZK 34929 |
| Cyndi Lauper: She's So Unusual | RK 38930 |
| Ramsey Lewis: Sun Goddess | CK 33194 |
| Kenny Loggins: High Adventure | CK 38127 |
| Loverboy: Get Lucky | CK 32638 |
| Loverboy: Keep It Up | CK 38703 |
| Chuck Mangione: Journey to a Rainbow | CK 38686 |
| Johnny Mathis: The Best of Johnny Mathis | CK 36871 |
| Johnny Mathis: Special Part of Me | CK 38718 |
| Wynton Marsalis: Think of One | CK 38641 |
| Wynton Marsalis: Wynton Marsalis | CK 37547 |
| Paul McCartney: Pipes of Peace | CK 39249 |
| Paul McCartney: Tug of War | CK 37462 |
| Paul McCartney & Wings: Band on the Run | CK 36482 |
| Meatloaf: Bat Out of Hell | EK 34974 |
| Men At Work: Business As Usual | CK 37978 |
| Men At Work: Cargo | CK 38660 |
| Willie Nelson: Always On My Mind | CK 37951 |
| Willie Nelson: Stardust | CK 35305 |
| Nena: 99 Luftballons | EK 39294 |
| Nine: Original Cast Recording | CK 38325 |
| Aldo Nova: Aldo Nova | RK 37498 |
| Mike Oldfield: Crises | CDV 2262 |
| Mike Oldfield: Tubular Bells | CDV 2001 |
| Jane Oliver: Stay The Night | CK 35437 |
| Ozzy Osbourne: Bark at the Moon | ZK 38987 |
| Steve Perry: Street Talk | CK 39334 |
| Pink Floyd: The Final Cut | CK 38243 |
| Pink Floyd: Wish You Were Here | CK 33453 |
| Psychedelic Furs: Mirror Moves | CK 39278 |
| Quiet Riot: Metal Health | ZK 38443 |
| REO Speedwagon: Hi-Infidelity | EK 36844 |
| Romantics: In Heat | ZK 38880 |

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| Saga: Heads or Tails | RK 38999 |
| Santana: Abraxas | CK 30130 |
| Santana: Shango | CK 38122 |
| Boz Scaggs: Silk Degrees | CK 33920 |
| Scanda: Hands Tied | CK 39173 |
| Simple Minds: New Gold Dream | CDV 2230 |
| Ricky Skaggs: Highways and Heartaches | EK 37996 |
| Slade: Keep Your Hands Off | ZK 39336 |
| Bruce Springsteen: Born In the U.S.A. | CK 38653 |
| Bruce Springsteen: Born To Run | CK 33795 |
| Bruce Springsteen: Darkness on the Edge of Town | CK 35318 |
| Bruce Springsteen: Nebraska | CK 38358 |
| Bruce Springsteen: The Wild, the Innocent, and the E Street Shuffle | CK 32432 |
| Barbra Streisand: Greatest Hits Volume 2 | CK 35679 |
| Barbra Streisand: Guilty | CK 36750 |
| Barbra Streisand: The Way We Were | CK 32801 |
| James Taylor: Dad Loves His Work | CK 37009 |
| James Taylor: JT | CK 34881 |
| Toto: Toto IV | CK 37728 |
| Toto: Turn Back | CK 36813 |
| Bonnie Tyler: Faster than the Speed of Night | CK 38710 |
| Luther Vandross: Busy Body | EK 39196 |
| Stevie Ray Vaughn: Texas Flood | EK 38734 |
| Roger Waters: Pros & Cons of Hitchhiking | CK 39290 |
| Matthew Wilder: Speak the Language | ZK 39112 |
| Weather Report: Heavy Weather | CK 34418 |
| Weather Report: Night Passage | CK 36793 |

Centaur Records

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| Eastman Winds: Hanson & Benson | CNT 2014 |
| Schubert: Death & the Maiden | CNT 2013 |

Chandos Records

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| Bax: November Woods & The Happy Forest | CHN 8307 |
| Elgar: From the South/Handel: Overtures | CHN 8309 |
| Holst: The Planets, Scottish National Orchestra, Gibson | CHN 8302 |
| London Symphony Orchestra: Rare Orchestra Music | CHN 8310/11 |
| Purcell: Dido & Aeneas | CHN 8306 |
| Schubert: Piano Trio No. 1 | CHN 8308 |
| Sibelius: Symphony No. 2/Scottish National Orchestra, Gibson | CHN 8303 |
| Tchaikovsky: Symphony No. 2/London Symphony Orchestra, Gibson | CHN 8304 |
| Weber: Clarinet Concertos Nos. 1 & 2 | CHN 8305 |

Clave Records

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|---|------------|
| Krommer: Flute & Oboe/Holliger | CLV 3111-1 |
| Mozart: Arias/E. Haefliger | CLV 8305 |
| Mozart: Bassoon & Clarinet Concerto | CLV 8205 |
| Music for Voice and Instrument/Berganza | CLV 3111-5 |
| Schubert: The Beautiful Miller's Daughter | CLV 3111-3 |
| Schumann and Mussorgsky | CLV 3111-4 |

Delos Records

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| American Brass Quintet: Renaissance, Elizabethan, Baroque Music | D/CD 3003 |
| The Baroque Virtuoso: Toccatas of Bach, Buxtehude, Hanff, Oley, Bruhns, and Krebs | D/CD 1001 |
| Beethoven: Piano Sonatas Op. 57 (Appassionata)/Bosendorfer Imperial Grand | D/CD 3009 |
| Beethoven: Symphony Nos. 1 & 8/Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3013 |
| Beethoven: Symphony No. 6 in F Major/Y Chamber Symphony of New York, Gerard Schwarz | D/CD 3017 |
| Bejun: Bejun Mehta, boy soprano of the Los Angeles Chamber Orchestra | D/CD 3019 |
| A Distant Mirror: Music from 14th Century/The Folger Consort | D/CD 1003 |
| Dvorak: Serenade Op. 22, Waldesruhe (Silent Woods) for Cello and Orchestra, Op. 68, Notturno, Op. 40/Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3011 |
| Handel: Water Music/Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3010 |
| Haydn/Hummel: Classic Trumpet Concerti/Y Chamber Symphony of New York, Gerard Schwarz | D/CD 3001 |
| Mozart: Serenade in B Flat, K. 361 (Gran Partita/Chicago Symphony Winds) | D/CD 3020 |
| Mozart: Symphony Nos. 40 & 41, K. 550 & 551, (Jupiter) Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3012 |
| Ravel Quartet/Bartok Quartet No. 3: Sequoia String Quartet | D/CD 3004 |
| Mavis Rivers: It's A Good Day | D/CD 4002 |
| Schubert: Sonata in B Flat Major, D. 960/Bosendorfer Imperial Grand | D/CD 3018 |
| Shakespeare's Music: The Folger Consort | D/CD 1002 |
| Bobby Shev/Chuck Findley: Trumpets No End | D/CD 4003 |
| The Sound of Trumpets: New York Trumpet Ensemble/Y Chamber Symphony of New York, Gerard Schwarz | D/CD 3002 |
| Stravinsky: Histoire du Soldat/Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3014 |
| Stravinsky: Histoire du Soldat (Suite)/Prokofiev: Classical Symphony/Shostakovich Concerto No. 1/Los Angeles Chamber Orchestra, Gerard Schwarz | D/CD 3008 |
| Tchaikovsky: Symphony No. 5, Op. 64/Philadelphia Orchestra, Eugene Ormandy | D/CD 3015 |

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| Tchaikovsky: Symphony No. 6, Op. 74/Philadelphia Orchestra, Eugene Ormandy | D/CD 3016 |
| Vivaldi: The Four Seasons/L.A. Chamber Orchestra, Gerard Schwarz | D/CD 3007 |
| Water Music of the Impressionists | D/CD 3006 |
| Joe Williams: Nothin' But the Blues | D/CD 4001 |
| The World of Harp: Susann McDonald, Harp Concert, Paraguayan and Irish Harps | D/CD 3005 |

Denon Records

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| Bach: Die Grosse Silbermannorgel/Toccata & Fugue in d Minor, Hans Otto | CD 7004 |
| Bach: Favourite Melodies | CD 7148 |
| Bach: Sonatas for Flute and Harpsichord Obbligato Based on Variations of Trio Sonatas | CD 7058 |
| Bach: Three Concertos for Violin & Orchestra/Munchener Kammerorchester, J.J. Kantorow | CD 7096 |
| Bach: Trio Sonatas/Heinz Holliger, oboe/Aurele Nicolet, flute | CD 7093 |
| J.S. Bach: Concerto in d Minor, BMV 1060 & Concerto in a Minor, BMV 1044/Netherlands Chamber Orchestra, Kees Bakerls | CD 7064 |
| J.S. Bach: Die Orgelmeisterwerke/Orgel Der Gedächtniskirche, Stuttgart | CD 7039 |
| J.S. Bach: Musikalisches Opfer BMV 1079/ Orchestre de Chambre Jean, Francois Pallard | CD 7048 |
| Bela Bartok: Music for Strings, Percussion and Celesta, Rumanian Folk Dances | CD 7122 |
| Bartok: Schiff Plays Bartok/Dance Suite, Hungarian Peasant Songs/ Andras Schiff | CD 7092 |
| Beethoven: Quintet in E Flat Major/Winds of Berlin Philharmonic | CD 7090 |
| Beethoven: Symphony No. 3 (Eroica)/Staatskapelle Berlin, Otmar Sutiner | CD 7011 |
| Beethoven: Symphony No. 4 | CD 7077 |
| Beethoven: Symphony No. 5/Staatskapelle Berlin, Otmar Sutiner | CD 7001 |
| Beethoven: Symphony No. 6 (Pastorale)/Staatskapelle Berlin, Otmar Sutiner | CD 7040 |
| Beethoven: Symphony No. 7/Staatskapelle Berlin, Otmar Sutiner | CD 7032 |
| Beethoven: Symphony No. 9 (Choral)/Staatskapelle Berlin, Otmar Sutiner | CD 7021 |
| Beethoven: String Quartets/Smetana Quartet | CD 7025 |
| Beethoven: String Quartets/Smetana Quartet | CD 7033 |
| Beethoven: String Quartets/Smetana Quartet | CD 7036 |
| Beethoven: String Quartets Nos. 2 & 4/Smetana Quartet | CD 7041 |
| Beethoven: String Quartets Nos. 3 & 6/Smetana Quartet | CD 7049 |
| Beethoven: String Quartet No. 9, Rasoumovsky No. 3, String Quartet No. 10, Harp/Smetana Quartet | CD 7125 |
| Beethoven: String Quartets Nos. 11 & 12/Smetana Quartet | CD 7063 |
| Beethoven: String Quartet No. 13 in B Flat Major/Smetana Quartet | CD 7088 |
| Beethoven: String Quartet No. 15 in a Minor, Op. 132/Smetana Quartet | CD 7086 |
| Beethoven: Symphonies Nos. 1 & 8/Staatskapelle Berlin | CD 7128 |
| Beethoven: Trio for Violin and Piano No. 7 | CD 7078 |
| Berlioz: Symphonie Fantastique/Tokyo Metropolitan Orchestra, Jean Forneri | CD 7087 |
| Bi Celebres, Elgar: Salut D'Amour/Mari Fujiwara, Alain Planes | CD 7044 |
| Bouquet of Piano Music | CD 7150 |
| Bruckner: Symphony No. 4 Romantiche/Staatskapelle Dresden | CD 7126 |
| Chopin: Valse Brillante/Jean-Yves Thibaudet | CD 7050 |
| CD Professional Test | CD 7147 |
| F. Couperin: Concert Royal No. 4/Maxence Larrieu, Robert Veyron-Lacroix | CD 7069 |
| F. Couperin: Pieces De Clavecin/Huguette Dreyfus | CD 7070 |
| Claude Debussy: Prélude Duexieme Livre/Jacques Rouvier | CD 7043 |
| Claude Debussy: Prélude Premier Livre/Jacques Rouvier | CD 7121 |
| Dvorak: From the New World/Czech Philharmonic, Vaclav Newmann | CD 7002 |
| Dvorak: Trio No. 4 Dumky/Suk Trio | CD 7057 |
| Favorite Guitar Pieces: Tokyo Metropolitan Symphony Orchestra | CD 7054 |
| Franck/Ravel: Violin Sonatas | CD 7079 |
| Handel: 4 Sonatas for Violin and Harpsichord/Josef Suk | CD 7053 |
| Handel: Sonatas/Hans Hollinger | CD 7026 |
| Haydn: String Quartets/Philharmonia Quartet Berlin | CD 7094 |
| Historical Organ at the St. Nicholas Bovenkerk in Kampen | CD 7120 |
| Holliger Chamber Music for Oboe and Strings | CD 7119 |
| Invitation to Baroque Music: Societas Musica Chamber Orchestra, Jorgen Ernst Hansen | CD 7037 |
| Japanese Favorite Melodies on Baroque: Vivaldi Ensemble Tokyo, Masaaki Hayakawa | CD 7065 |
| Yoshiro Kanno: Four Seasons in Resonance/Tomoyuki Okada Percussion Ensemble | CD 7042 |
| Kantarow/Zigeunerweisen: New Japan | CD 7005 |
| Philharmonic, Jean-Jacques Kantarow | CD 7066 |
| Liebestraume: Ensemble Lunaire/Ayako Shinozaki | CD 7009 |
| Lyrical Melodies of Japan: Andras Adorjan, flute/Ayako Shinozaki, harp | CD 7127 |
| Melodies Japonaises: J.P. Rampal, flute/L. Laskine, harp | CD 7123 |
| Mendelssohn: Violin Concerto in e Minor, Op. 64/Bruch: Violin Concerto No. 1 in g Minor, Op. 26/Netherlands Chamber Orchestra, Antoni Ros-Marba | CD 7038 |
| Mozart: Clarinet Quintet/Philharmonia Quartet Berlin, Sabine Meyer | CD 7003 |
| Mozart: String Quartets KV498, KV421/Smetana Quartet | CD 7034 |
| Mozart: String Quartet-Quintet/Philharmonia Quartet Berlin, Hansjör Schellenberger | CD 7179 |
| Mozart: String Quintets Nos. 2 & 6/Smetana Quartet, Joseph Suk | CD 7014 |

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| Mozart: String Quintet Nos. 1 & 5 | CD 7075 |
| Mozart: Symphony No. 38 in D Major, Symphony No. 39 in E Flat Major/Staatskapelle Dresden | CD 7146 |
| Mozart: Symphonies Nos. 40 & 41 (Jupiter)/Staatskapelle Dresden, Herbert Blomstedt | CD 7022 |
| W.A. Mozart: Divertimento in F Major, Serenade in G Major/ Festival Strings Lucern | CD 7080 |
| W.A. Mozart: Four Flute Quartets/Mozart String Trio | CD 7157 |
| W.A. Mozart: Le Nozze di Figaro/Netherlands Wind Ensemble | CD 7124 |
| W.A. Mozart: Symphonies Nos. 38 (Prague) & 36 (Linz)/NHK Symphony Orchestra, Otmar Sutiner | CD 7051 |
| Mussorgsky: Tableaux dans l'Exposition, Jacques Rouvier, piano | CD 7177 |
| Organ Concert at Holmens Church: Jorgen Ernst Hansen | CD 7059 |
| Organ Concert at Our Saviour's Church: Charley Olson | CD 7015 |
| Organ Concert at the Stadtkirche St. Nikolaus, Frauenfeld: Heinz Balli | CD 7068 |
| Romance and Souvenir | CD 7149 |
| Romantic Overtures: Tokyo Metropolitan Symphony Orchestra, Kenichiro Kobayashi | CD 7012 |
| Scarlatti: 14 Sonatas for Harpsichord | CD 7095 |
| Schubert: Symphonies Nos 5 & 8/Staatskapelle Berlin, Otmar Sutiner | CD 7156 |
| Schubert: Symphony No. 9/Berlin Radio Symphony, Rogner | CD 7035 |
| J.P. Sweelinck: Organ Works/Jacques Van Oortmerssen | CD 7024 |
| Tchaikovsky: Symphony No. 5 in e Minor, Op. 64/Berlin Symphony Orchestra, Kurt Sanderling | CD 7100 |
| Tchaikovsky: Symphony No. 6 (Pathétique)/Berlin Symphony Orchestra, Kurt Sanderling | CD 7062 |
| Telemann: Der Getreue Music-Meister/Heinz Holliger, Klaus Thunemann, Christiane Jacquot | CD 7052 |
| Telemann: 12 Fantasias/Heinz Holliger | CD 7089 |
| Ten Glorious Organs in Europe | CD 7180 |
| Violoncello Concertos: Netherlands Chamber Orchestra, Michi Inoue | CD 7023 |
| Vivaldi: Concerto in F Major, Concerto in D Major | CD 7178 |
| Vivaldi: Four Concerti for Piccolo & Orchestra | CD 7076 |
| Vivaldi: The Four Seasons/Festival Strings Lucerne | CD 7013 |

Denon Records (Jazz)

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| Ambrosia/Art Farmer with Great Jazz Trio | CD 7091 |
| CD Demo # 1 | TD-9001 |
| CD Demo # 2 | TD-9004 |
| Fantasy on Synthesizer | CD 7176 |
| Art Farmer/Ron Carter: Maiden Voyage | CD 7071 |
| R. Furusawa/Lee Oscar: Anokoro | CD 7138 |
| Eddie Gomez/Chick Corea | CD 7189 |
| Billy Harper: Soran Bushi | CD 7007 |
| Terry Herman Trio: Begin the Beguine | CD 7055 |
| Terry Herman Trio: Blue Aranjuez | CD 7010 |
| Terry Herman Trio: Blue Michelle | CD 7130 |
| Hank Jones/Eddie Gomez: The Club New Yorker/The Great Jazz Trio | CD 7072 |
| Jo Jones: Our Man, Papa Jo! | CD 7047 |
| Loudness: Disillusion | CD 7134 |
| N.Y. Sophisticate: Tribute to Duke Ellington | CD 7079 |
| Eri Ohno: Easy to Love | CD 7085 |
| Eri Ohno: Eri, My Dear | CD 7016 |
| Ryuichi Sakamoto: Thousand Knives | CD 7137 |
| Ryuichi Sakamoto and Danceries: End of Asia | CD 7045 |
| Archie Shepp/Dollar Brand: Duet | CD 7008 |
| Sonny Stitt: Moonlight in Vermont | CD 7046 |
| Surfing and Summer Breeze | CD 7184 |
| This Is Denon CD | CD 7060 |
| Tokyo Brass Ensemble: Digital March | CD 7027 |
| Kazumi Watanabe: Kylyn | CD 7135 |
| Kazumi Watanabe: Lonesome Cat | CD 7017 |
| Kazumi Watanabe: To Chi Ka | CD 7136 |
| Nancy Wilson: I'll Be A Song | CD 7061 |
| Nancy Wilson: Godsend | CD 7180 |

Deutsche Grammophon (see PolyGram Records)

Digital Music Products

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|---|---------|
| Billy Barber: Shades of Gray | CD 445 |
| Joe Beck: Friends | CD 446 |
| Joe Beck: Relaxin' | CD 444 |
| Warren Bernhardt Trio: '83 | CD 441 |
| Film & the BB's: Tricycle | CD 443 |
| Film & the BB's: Tunnel | CD 447 |
| Jay Leonhart: Salamander Pie | CD 442 |
| Jim Pugh and Dave Taylor: The Pugh-Taylor Project | CD 448 |
| Various Artists: DMP Sampler | CS 4001 |

ECM Records

(see Warner Communications)



Elektra/Asylum Records

(see Warner Communications)

Elektra/Asylum/Musician Records

(see Warner Communications)

Geffen Records

(see Warner Communications)

GRP Records

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| Kevin Eubanks: Sundance | GRP D 9506 |
| Dave Grusin: Mountain Dance | GRP D 9507 |
| Dave Grusin: Night Lives | GRP D 9504 |
| Dave Grusin and the NY/LA Dream Band | GRP D 9501 |
| Glenn Miller Orchestra: In The Digital Mood | GRP D 9502 |
| Gerry Mulligan: Little Big Horn | GRP D 9503 |
| Special EFX: Special EFX | GRP D 9505 |
| Dave Valentini: Untitled | GRP D 9508 |

Harmonia Mundi

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| Ancient Dances of Hungary | HM 901003 |
| Chapentier: Concert in D/Christie | HM 901095 |
| La Folia D'Espana | HM 901050 |
| Mozart: Clarinet Quintet/Musiciens | HM 901118 |
| Music of Ancient Greece | HM 901015 |
| Music of King Arthur/Deller Consort | HM 90252 |
| Purcell: Deller Consort | HM 90249 |
| Rameau: Harps Works/Christie | HM 901120 |
| Rameau: Motets | HM 901078 |

Hungaraton Records

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| Bartok: Bluebeard's Castle | HNG 12254 |
| Gypsy Music: Sandr Lakatos | HNG 10178 |
| Haydn: Harmoniesmesse/Slovak | HNG 12360 |
| Liszt: Preludes/Ferencsik | HNG 12446 |
| Mendelssohn: Symphonies Nos. 4 & 5/ | |
| Hungarian Strings | HNG 12414 |
| Puccini: Suor Angelica | HNG 12490 |

IRS Records

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| The Alarm: Declaration | CD 70608 |
| The English Beat: Special Beat Service | CD 70032 |
| The English Beat: What Is Beat? | CD 70040 |
| Go Go's: Beauty and the Beat | CD 70021 |
| Go Go's: Talk Show | CD 70041 |
| REM: Murmur | CD 70604 |
| REM: Reckoning | CD 70044 |

Island Records

(see Warner Communications)

Koala Records

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| P. Herbolzheimer: Bandfire | CDP 1 |
| P. Herbolzheimer: Fat Man Boogie | CDP 2 |
| P. Herbolzheimer: Fat Man 2 | CDP 3 |

L'Oiseau Lyre Records

(see PolyGram Records)

London Records

(see PolyGram Records)

MCA Records

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| Evita: Original Cast Recording | MCA 11003 |
| Elton John: Greatest Hits | MCA 37215 |
| Elton John: Goodbye Yellow Brick Road | MCA 06894 |
| Olivia Newton-John: Greatest Hits Vol. 2 | MCA 05347 |
| Olivia Newton-John: Physical | MCA 05229 |
| Steely Dan: Aja | MCA 37214 |
| Steely Dan: Gaucho | MCA 37220 |

Mobile Fidelity Sound Lab

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| Louis Armstrong & Duke Ellington: Together for the First Time | MFCD 807 |
| Alan Parsons: I Robot | MFCD 804 |
| Art Pepper & Eleven: Modern Jazz Classic | MFCD 805 |
| Andrew Powell: The Best of Alan Parsons | MFCD 806 |
| Prokofiev: Nevsky, Op. 78/St. Louis Symphony & Chorus, Leonard Slatkin | MFCD 808 |
| Ravel: Bolero, Rapsodie Espagnole/Minnesota Orchestra, Stanislaw Skrowaczewski | MFCD 802 |

Sonny Rollins: Way Out West
Al Stewart: Year of the Cat

MFCD 801
MFCD 803

The Moss Music Group

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| All-Star Percussion Ensemble: Works of Bizet, Beethoven, Pachelbel, and Berlioz/Harold Farberman, conductor | MCD 10007 |
| Art of Trumpet: New York Trumpet Ensemble/Edward Carroll, trumpet, Edward Brewer, organ | MCD 10001 |
| Debussy: Images, Books I & II/Estampes | MCD 10003 |
| Peaches & Cream: Dances and Marches by John Philip Sousa/Cincinnati Pops Orchestra, Erich Kunzel | MCD 10005 |
| Schubert: Piano Sonata in A Major | MCD 10030 |
| Schubert: String Quartets Nos. 12 & 14/Tokyo String Quartet | MCD 10004 |
| Strauss: Oboe Concerto/Lutoslawski: Double Concerto for Oboe, Harp, and Chamber Orchestra/Cincinnati Symphony Orchestra, Michael Gielen | MCD 10006 |
| Stravinsky: The Rite of Spring/Moscow Radio Symphony Orchestra, Vladimir Fedoseev | MCD 10029 |
| Tchaikovsky: Excerpts from The Seasons/Rachmaninov: Excerpts from Etudes-Tableaux | MCD 10031 |
| Tchaikovsky: Symphony No. 6/Moscow Radio Symphony Orchestra, Vladimir Fedoseev | MCD 10028 |

Motown Records

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| Commodores: 14 Greatest Hits | MOTD 6068 |
| Marvin Gaye: 15 Greatest Hits | TAMD 6069 |
| Michael Jackson & The Jackson 5: 18 Greatest Hits | MOTD 6070 |
| Lionel Richie: Lionel Richie | MOTD 6007 |
| Lionel Richie: Can't Slow Down | MOTD 6059 |
| Smoky Robinson & The Miracles: 18 Greatest Hits | TAMD 6071 |
| Diana Ross: 14 Greatest Hits | MOTD 6072 |
| Diana Ross & The Supremes: 20 Greatest Hits | MOTD 6073 |

Musician Records

(see Warner Communications)

Nautilus Records

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| Victor Feldman: Secret of the Andes | |
| Victor Feldman: Soft Shoulder | |
| Maynard Ferguson: Storm | |
| John Kay & Steppenwolf: Wolf Tracks | |
| Marcel Moyse: Conducting the Marlboro Alumni | |
| Sonny Rollins: Ins and Outs | |

Nimbus Records

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| Elgar: String Works | CDNIM 5008 |
| Mozart: Violin Concertos | CDNIM 5009 |
| Medieval Ensemble: Martin Best | CDNIM 5002 |
| Ravel: Piano Works/V. Perlmutter | CDNIM 5005 |

Nonesuch Records

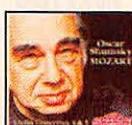
(see Warner Communications)

Philips Records

(see PolyGram Records)

Pierre Vernay Records

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| Bach: Organ Works/Bardon | PV710811 |
| Banjo Express | PV710781 |
| La Harpe Indienne | PV782111 |
| Liszt: Organ Work/DeZeeum | PV783041 |
| Mamba Percussion | PV78291 |
| Mamba Percussion Volume 2 | PV784051 |
| Organ Recital: Louis Vierne | PV784041 |
| 17th Century French Organ Music | PV784011 |
| Songs of the Province/Fleur De Rose | PV782112 |
| Test Disc | PV784031 |
| Vivaldi: Concerto Organ | PV79801 |
| Walker Band: Big Band Story | PV783092 |





PolyGram Records

Deutsche Grammophon

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| Albinoni: Adagio/Pachelbel: Kanon/Berlin Philharmonic, Herbert von Karajan | 413 309-2 GH |
| Bach: Brandenburg Concertos 1-3/English Concert, Trevor Pinnock | 410 500-2 AH |
| Bach: Brandenburg Concertos 4-6/English Concert, Trevor Pinnock | 410 501-2 AH |
| Bach: Concertos for 3 & 4 Harpsichords/English Concert, Trevor Pinnock | 400 041-2 AH |
| Bach: Toccata & Fugue/Koopman | 410 999-2 GH |
| Bach: Violin Concertos BMV 1041-1043/English Concert, Trevor Pinnock | 410 646-2 AH |
| Beethoven: Hammerklavier, Emil Gilels | 410 527-2 |
| Beethoven: Moonlight, Pathetique, Sonata 13/Emil Gilels | 400 036-2 GH |
| Beethoven: Piano Concerto No. 1/Vienna Philharmonic Orchestra, Maurizio Pollini | 410 511-2 GH |
| Beethoven: Symphony No. 5/L.A. Philharmonic Orchestra, Carlo Maria Giulini | 410 028-2 GH |
| Berlioz: Cleopatre, Nuits d'Ete/Orchestre de Paris, Kiri Te Kanawa | 410 966-2 |
| Berlioz: Te Deum, Araiza, Abbado/London Symphony Orchestra Chorus/Community Youth Orchestra | 410 696-2 |
| Berlioz: Symphonie Fantastique/Chicago Symphony Orchestra, Claudio Abbado | 410 895-2 |
| Bizet: Carmen/Berlin Philharmonic | 410 088-2 GH3 |
| Brahms: Ballades/Schubert: Sonata D. 537/Arturo Benedetti Michelangeli | 400 043-2 GH |
| Brahms: Cello Sonatas/Mstislav Rostropovich | 410 510-2 GH |
| Brahms: Double Concerto in A Minor, Op. 102/Berlin Philharmonic, Herbert Karajan | 410 603-2 GH |
| Brahms: Symphony No. 1/Vienna Philharmonic Orchestra, Leonard Bernstein | 410 081-2 GH |
| Brahms: Symphony No. 1/L.A. Philharmonic, Carlo Maria Giulini | 410 023-2 |
| Brahms: Symphony No. 2/Vienna Philharmonic Orchestra, Leonard Bernstein | 410 082-2 GH |
| Brahms: Symphony No. 2/L.A. Philharmonic, Carlo Maria Giulini | 400 066-2 GH |
| Brahms: Symphony No. 3, Haydn Variations/Vienna Philharmonic Orchestra, Leonard Bernstein | 410 083-2 GH |
| Brahms: Symphony No. 4, Tragic Overture/Vienna Philharmonic Orchestra, Leonard Bernstein | 410 084-2 GH |
| Brahms: Violin Concerto/Vienna Philharmonic Orchestra, Leonard Bernstein | 410 029-2 GH |
| Brahms: Violin Concerto/Berlin Philharmonic Orchestra, Anne-Sophie Mutter | 400 064-2 GH |
| Chopin: Piano Concerto No. 2/Ivo Pogorelich | 410 507-2 |
| Domingo Gala Opera Concert: Los Angeles Philharmonic, Carlo Maria Giulini | 400 030-2 GH |
| Dvorak: Symphony No. 9 (New World)/Vienna Philharmonic Orchestra, Lorin Maazel | 410 032-2 GH |
| Franck: Symphonie, Rouet d'Orphale/Orchestre National de France, Leonard Bernstein | 400 070-2 GH |
| Gershwin: Rhapsody In Blue/Berstein: West Side Story/Los Angeles Philharmonic | 410 025-2 GH |
| Grieg: Peer Gynt/Sibelius: Pellaes/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 026-2 GH |
| Handel: Concerti Grossi, Op. 6, Nos. 1-4, English Concert, Trevor Pinnock | 410 897-2 AH |
| Handel: Coronation Anthems/Westminster Abbey Choir/English Concert, Simon Preston | 410 030-2 AH |
| Handel: Dettingen Te Deum/Westminster Abbey Choir, Simon Preston | 410 647-2 |
| Handel: Water Music/The English Concert | 410 525-2 AH |
| Haydn: Creation/Herbert von Karajan | 410 718-2 |
| Haydn: Symphonies 94 & 101/Herbert von Karajan | 410 869-2 |
| Haydn: Symphonies 96 & 100/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 975-2 |
| Haydn: Symphonies 103 & 104 (Drum Roll & London)/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 517-2 GH |
| Holst: The Planets/Berlin Philharmonic Orchestra, Herbert von Karajan | 400 028-2 GH |
| Lalo: Symphonie Espagnole/Berlioz: Reverie Orchestre de Paris, Itzhak Perlman | 400 032-2 GH |
| Mahler: Symphony No. 1/Chicago Symphony Orchestra, Claudio Abbado | 400 033-2 GH |
| Mahler: Symphony No. 3/Vienna Philharmonic Orchestra, Claudio Abbado | 410 715-2 GH2 |
| Mahler: Symphony No. 9/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 726-2 GH2 |
| Mendelssohn & Bruch: Violin Concertos/Berlin Philharmonic Orchestra, Anne-Sophie Mutter | 400 031-2 GH |
| Mozart: Eine kleine Nachtmusik, Musical Joke, Amadeus Quartet | 400 065-2 GH |
| Mozart: Eine kleine Nachtmusik, Posthorn Serenade/Vienna Philharmonic Orchestra, James Levine | 410 085-2 GH |
| Mozart: Great Mass in c/Berlin Philharmonic Orchestra, Herbert von Karajan | 400 067-2 GH |

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| Mozart: Kleine Nachtmusik/Grieg: Holberg/Prokofiev: Classical/Berlin Philharmonic, Herbert von Karajan | 400 034-2 GH |
| Mozart: Magic Flute/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 967-2 |
| Mozart: Piano Concerti Nos. 9 & 11/English Baroque Soloists | 410 905-2 |
| Mozart: Piano Concerti Nos. 12 & 20/London Symphony Orchestra, Rudolf Serkin | 400 068-2 GH |
| Mozart: Piano Concerti Nos. 19 & 25/London Symphony Orchestra, Rudolf Serkin | 410 989-2 |
| Mozart: Piano Concerti Nos. 23 & 21 (Elvira Madigan)/London Symphony Orchestra, Rudolf Serkin | 410 068-2 GH |
| Mozart: Violin Concertos Nos. 3 & 5, Vienna Philharmonic Orchestra, Itzhak Perlman | 410 020-2 GH |
| Mozart: Violin Sonatas, K. 301-304/Itzhak Perlman | 410 896-2 |
| Mussorgsky: Pictures/Ravel: La Valse/London Symphony Orchestra, Claudio Abbado | 410 033-2 GH |
| New Year Concert In Vienna: Vienna Philharmonic Orchestra, Lorin Maazel | 400 040-2 GH |
| Offenbach: Overtures/Berlin Philharmonic Orchestra, Herbert von Karajan | 400 044-2 GH |
| Pachelbel: Kanon/Vivaldi: La Follia/Musica Antiqua Köln | 410 502-2 AH |
| Prokofiev: Romeo & Juliet/National Symphony Orchestra, Mstislav Rostropovich | 410 519-2 GH |
| Prokofiev: Violin Concertos/Chic Symphony Orchestra, Shlomo Mintz | 410 524-2 GH |
| Puccini: Turandot/Vienna Philharmonic Orchestra, Herbert von Karajan | 410 096-2 GH3 |
| Rachmaninoff: Symphony Dances, Vocalise, Intermezzo/Berlin Philharmonic Orchestra, Lorin Maazel | 410 894-2 |
| Ravel: Bolero/Valse/Pavane/Daphnis/Orchestre de Paris, Daniel Barenboim | 400 061-2 GH |
| Ravel: Gaspard de la nuit/Prokofiev: Piano Sonata No. 6/Pogorelich | 410 363-2 GH |
| Rossini: Stabat Mater/Philharmonia Orchestra & Chorus, Carlo Maria Giulini | 410 034-2 GH |
| Saint-Saens: Organ Symphony/Berlin Philharmonic, Herbert von Karajan | 400 063-2 GH |
| Saint-Saens/Wieniawski: Violin Concertos/Orchestre de Paris, Itzhak Perlman | 410 526-2 GH |
| Schubert: Death & Maiden/Amadeus Quartet | 410 024-2 GH |
| Schubert: Unfinished/Mendelssohn: Italian, Giuseppe Sinopoli | 410 862-2 |
| Schumann: Kinderscene/Martha Argerich | 410 653-2 |
| Schumann: Symphony No. 2/Giuseppe Sinopoli | 410 863-2 |
| Schumann: Symphony No. 3 (Rhenish)/Los Angeles Philharmonic, Giulini | 400 062-2 GH |
| Schumann: Symphonic Etudes/Beethoven: Piano Sonata No. 32 in C Minor, Op. 111 | 410 520-2 GH |
| Shostakovich: Symphony No. 5/National Symphony Orchestra, Rostropovich | 410 509-2 GH |
| Strauss: Blue Danube/Berlin Philharmonic Orchestra, Herbert von Karajan | 400 026-2 GH |
| Strauss: Don Juan, Till Eulenspiegel, Death and Transfiguration/London Symphony Orchestra, Claudio Abbado | 410 518-2 |
| Strauss: Emperor Waltzes/Berlin Philharmonic, Herbert von Karajan | 410 022-2 GH |
| Strauss: Radetzky March, Herbert von Karajan | 410 027-2 |
| Strauss: Zarathustra, Don Juan/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 959-2 GH |
| R. Strauss: Death and Transfiguration, Berlin Philharmonic Orchestra, Herbert von Karajan | 410 892-2 GH |
| R. Strauss: An Alpine Symphony/Berlin Philharmonic Orchestra, Herbert von Karajan | 400 039-2 GH |
| Stravinsky: Petrouchka/London Symphony Orchestra, Claudio Abbado | 400 042-2 GH |
| Stravinsky: The Rite of Spring/Israel Philharmonic, Leonard Bernstein | 410 508-2 GH |
| Tchaikovsky: 1812 Overture/Chicago Symphony Orchestra, Daniel Barenboim | 400 035-2 GH |
| Tchaikovsky: Romeo & Juliet, Nutcracker/Berlin Philharmonic Orchestra, Herbert von Karajan | 410 873-2 |
| Tchaikovsky: Symphony No. 6 (Pathetique)/Los Angeles Philharmonic, Carlo Maria Giulini | 400 029-2 GH |
| Tchaikovsky: Violin Concerto, Serenade Melancolique/Berlin Philharmonic Orchestra, Lorin Maazel | 400 027-2 GH |
| Tchaikovsky & Dvorak: String Serenade/Berlin Philharmonic Orchestra | 400 038-2 GH |
| Verdi: Aida (complete)/La Scala Orchestra & Chorus, Claudio Abbado | 410 092-2 GH3 |
| Verdi: Falstaff/Los Angeles Philharmonic, Carlo Maria Giulini | 410 503-2 GH2 |
| Verdi: Nabucco/Giuseppe Sinopoli | 410 512-2 |
| Viennese Bonbons: New Year's Concert/Vienna Philharmonic Orchestra | 410 516-2 GH |
| Vivaldi: The Four Seasons/English Concert | 400 045-2 AH |

L'Oiseau Lyre Records

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| Bach: Violin Concertos/Christopher Hogwood | 400 080-2 |
| Corelli: Christmas Concert/Christopher Hogwood | 410 179-2 |
| Handel: The Messiah/Christopher Hogwood | 400 086-2 |
| Handel: Water/Academy of Ancient Music, Christopher Hogwood | 400 059-2 |
| Mozart: Symphonies Nos. 38 & 39/Academy of Ancient Music, Christopher Hogwood | 410 233-2 |
| Mozart: Symphonies Nos. 40 & 41/Academy of Ancient Music, Christopher Hogwood | 410 197-2 |
| Pachelbel: Kanon/Academy of Ancient Music, Christopher Hogwood | 410 553-2 |

London Records

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| Allegri: Palestrina, Monteverdi: Westminster Choir | 410 005-2 ZH |
| Bach: Brandenburgs 1, 2, & 4/Concentus Musicus Wien, Nikolaus Harnoncourt | 8.42823 |

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| Bach: Brandenburgs 3, 5, & 6/Concentus Musicus Wien, Nikolaus Harnoncourt | 8.42840 | Rachmaninov: Symphony No. 2/Concertgebouw Orchestra, Vladimir Ashkenazy | 400 081-2 LH |
| Bach: Violin Concertos/Academy of Ancient Music, Christopher Hogwood | 400 080-2 OH | Rachmaninov: Symphony No. 3/Concertgebouw Orchestra, Vladimir Ashkenazy | 410 231-2 LH |
| Bartok: Concerto of Orchestra, Dance Suite/Chicago Symphony Orchestra, Georg Solti | 400 052-2 LH | Ravel: Bolero, La Valse, etc./Montreal Symphony Orchestra, Charles Dutoit | 410 010-2 LH |
| Beethoven: Emperor Concerto/Israel Philharmonic Orchestra, Radu Lupu, Zubin Mehta | 400 050-2 LH | Ravel: Daphnis et Chloe/Montreal Symphony Orchestra, Charles Dutoit | 400 055-2 LH |
| Beethoven: Kreutzer, Spring/Izhak Perlman, Vladimir Ashkenazy | 410 554-2 LH | Ravel: Piano Concertos/Montreal Symphony Orchestra, Pascal Roge | 410 230-2 LH |
| Beethoven: Sonatas 14, 23, & 8/Vladimir Ashkenazy | 410 260-2 LH | Respighi: Pines, Fountains, Feste/Montreal Symphony Orchestra, Charles Dutoit | 410 145-2 LH |
| Beethoven: Symphony No. 5/Philharmonia Orchestra, Vladimir Ashkenazy | 400 060-2 LH | Rimsky-Korsakov: Scheherazade/Montreal Symphony Orchestra, Charles Dutoit | 410 253-2 LH |
| Beethoven: Symphony No. 6/Philharmonia Orchestra, Vladimir Ashkenazy | 410 003-2 LH | Rodrigo: Guitar Concerto, Fantasia/ Montreal Symphony Orchestra, Charles Dutoit | 400 054-2 LH |
| Beethoven: Violin Concerto/Vienna Philharmonic Orchestra, Kyung Wha Chung | 400 048-2 LH | Romantic Organ Music: Peter Hurford | 410 165-2 ZH |
| Beethoven/Liszt: Symphony No. 6/Katsaris | 8.42781 | Rossini: Boutique/Britten: Musicales/National Philharmonic Orchestra, Richard Bonynge | 410 139-2 LH |
| Berlioz: Damnation/Chicago Symphony Orchestra, Georg Solti | 410 181-2 LH | Rossini: Overtures/National Philharmonic Orchestra, Riccardo Chailly | 400 049-2 LH |
| Berlioz: Symphonie Fantastique/New York Philharmonic, Zubin Mehta | 400 046-2 LH | Saint-Saens: Symphony No. 3/Montreal Symphony Orchestra, Charles Dutoit | 410 201-2 LH |
| Brahms: Piano Concerto No. 1/Concertgebouw, Vladimir Ashkenazy | 410 009-2 LH | Schubert: Impromptus Op. 90 & 142/Rada Lupu | 411 711-2 LH |
| Brahms: Piano Concerto No. 2/Vienna Philharmonic Orchestra, Vladimir Ashkenazy | 410 199-2 LH | Schubert: Symphony No. 9/Vienna Philharmonic Orchestra, Georg Solti | 400 082-2 LH |
| Bruckner: Symphony No. 4/Chicago Symphony Orchestra, Georg Solti | 410 550-2 LH | Schumann/Saint-Saens: Cello Concertos/Cleveland Orchestra, Lynn Harrell | 410 019-2 LH |
| Canteloube: Songs of the Auvergne/Kiri Te Kanawa | 410 004-2 LH | Shostakovich: Symphony No. 5/Concertgebouw, Bernard Haitink | 410 017-2 LH |
| Chopin: Piano Works/Vladimir Ashkenazy | 410 180-2 LH | Shostakovich: Symphony No. 8/Concertgebouw, Bernard Haitink | 411 616-2 LH |
| Chopin: Piano Works Vol. 8/Vladimir Ashkenazy | 410 122-2 LH | Sibelius: Symphony No. 2/Philharmonia Orchestra, Vladimir Ashkenazy | 410 206-2 LH |
| Classics Meets Pops: 12 Cellists of the Boston Pops Orchestra | 8.42957 | Sibelius: Symphony No. 4/Philharmonia Orchestra, Vladimir Ashkenazy | 400 056-2 LH |
| Corelli: Christmas Concerto/Academy of Ancient Music, Christopher Hogwood | 410 179-2 OH | Sibelius: Symphony No. 5/Philharmonia Orchestra, Vladimir Ashkenazy | 410 016-2 LH |
| De Falla: Three-Cornered Hat/Montreal Symphony, Charles Dutoit | 410 008-2 LH | Strauss: Don Juan, Death & Transfiguration/Detroit Symphony, Antal Dorati | 400 085-2 LH |
| Dvorak: Cello Concerto/Bruch: Kol Nidre/Philharmonia Orchestra, Vladimir Ashkenazy | 410 144-2 LH | Strauss: Zarathustra, Macbeth/Detroit Symphony, Antal Dorati | 410 146-2 LH |
| Dvorak: Symphony No. 9 (New World)/Vienna Philharmonic Orchestra, Kondrashin | 400 047-2 LH | Stravinsky: Firebird/Detroit Symphony, Antal Dorati | 410 109-2 LH |
| Dvorak: Symphony No. 9 (New World)/Chicago Symphony Orchestra, Georg Solti | 410 116-2 LH | Stravinsky: Rite of Spring/Detroit Symphony, Antal Dorati | 400 084-2 LH |
| Faure: Pelleas, Masques/Academy of St. Martin-in-the-Fields, Marriner | 410 552-2 ZH | Sutherland/Pavarotti: Operatic Duets | 400 058-2 LH |
| Grofe: Grand Canyon/Gershwin: Porgy/Detroit Symphony Orchestra, Dorati | 410 110-2 LH | Tchaikovsky: Piano Concertos Nos. 1 & 3/ Vienna Symphony Orchestra, Victoria Postnikova | 410 112-2 LH |
| Handel: Messiah Highlights/Academy of Ancient Music, Christopher Hogwood | 400 086-2 LH | Tchaikovsky: Symphony No. 5/Vienna Philharmonic Orchestra, Chailly | 410 232-2 LH |
| Handel: Royal Fireworks Music, Water Music Suite, Arrival of the Queen of Sheba, and others/Philip Jones Brass Ensemble | 411 930-2 LH | Tchaikovsky: Symphony No. 6/Philharmonia Orchestra, Vladimir Ashkenazy | 411 615-2 LH |
| Handel: Water/Fireworks Music/Academy of Ancient Music, Christopher Hogwood | 400 059-2 LH | Tchaikovsky: Swan Lake, Nutcracker/Israel Philharmonic Orchestra, Zubin Mehta | 410 551-2 LH |
| Janacek: Sinfonietta, Taras Bulba/Vienna Philharmonic Orchestra, Mackerras | 410 138-2 LH | Tchaikovsky/Mendelssohn: Violin Concertos/Montreal Symphony Orchestra, Charles Dutoit | 410 011-2 LH |
| Liszt: Piano Music/Jorge Bolet | 410 257-2 LH | Verdi: La Traviata (Highlights), Sutherland, Pavarotti | 400 057-2 LH |
| Mahler: Symphony No. 2/Chicago Symphony Orchestra, Georg Solti | 410 202-2 LH | Verdi: Overtures/National Philharmonic Orchestra, Riccardo Chailly | 410 141-2 LH |
| Mahler: Symphony No. 9/Chicago Symphony Orchestra, Georg Solti | 410 012-2 LH | Verdi: La Traviata/Sutherland, Pavarotti/National Philharmonic Orchestra | 410 154-2 LH3 |
| Mozart: Concert Arias/Kiri Te Kanawa | 411 713-2 LH | Victoria/Palestrina: Masses, King's College | 410 149-2 ZH |
| Mozart: Concerto for Piano and Orchestra, K. 365/Chick Corea: Fantasy for Two Pianos/Fredrich Gulda: Ping Pong for Two Pianos/ Concertgebouw Orchestra, Nikolaus Harnoncourt | 8.42961 | Vivaldi: The Four Seasons/Academy of Ancient Music, Christopher Hogwood | 410 126-2 OH |
| Mozart: Concertos 22/19/Vienna Symphony Orchestra | 410 140-2 LH | Vivaldi: Gloria/St. John's Choir | 410 018-2 ZH |
| Mozart: Marriage of Figaro/London Philharmonic Orchestra, Georg Solti | 410 150-2 LH3 | Wagner: Ring Excerpts/Vienna Philharmonic Orchestra, Georg Solti | 410 137-2 LH |
| Mozart: Piano Concertos 12/13/Philharmonia Orchestra, Vladimir Ashkenazy | 411 612-2 LH | Wagner: Siegfried/Schoenberg: Verkarte/ English Chamber Orchestra/Ashkenazy | 410 111-2 LH |
| Mozart: Piano Concertos 15/16/Philharmonia Orchestra, Vladimir Ashkenazy | 410 214-2 LH | Philips Records | |
| Mozart: Piano Concertos 23/27/Philharmonia Orchestra, Vladimir Ashkenazy | 400 087-2 LH | Aisle Seat: John Williams/Boston Pops | 411 037-2 |
| Mozart: Requiem/Concentus Musicus Wien, Nikolaus Harnoncourt | 8.42756 | Bach: Brandenberg Concertos Nos. 1, 2, & 3/ Academy of St. Martin-in-the-Fields, Neville Marriner | 400 076-2 |
| Mozart: Serenade No. 10 in B Flat Major, K. 361/Winer Mozart- Blaser, Nikolaus Harnoncourt | 8.42981 | Bach: Brandenberg Concertos Nos. 4, 5, & 6/ Academy of St. Martin-in-the-Fields, Neville Marriner | 400 077-2 |
| Mozart: Symphonies Nos. 34 & 35/Concertgebouw Orchestra, Nikolaus Harnoncourt | 8.42703 | Bach: Toccata & Fugue/Daniel Chorzempa | 410 038-2 |
| Mozart: Symphonies Nos. 38 & 39/Academy of Ancient Music, Christopher Hogwood | 410 233-2 OH | Bach: Violin Concerti/Academy of St. Martin-in-the-Fields, Kremer | 411 108-2 |
| Mozart: Symphonies Nos. 40 & 31/Academy of Ancient Music, Christopher Hogwood | 410 197-2 OH | Beethoven: Violin Concerto/Academy of St. Martin-in-the-Fields, Neville Marriner | 410 549-2 |
| Mozart: Symphony No. 40 in g Minor, K. 550, Symphony No. 25 in g minor, K. 183/Concertgebouw Orchestra, Nikolaus Harnoncourt | 8.42935 | Beethoven: Piano Concerti/Chicago Symphony Orchestra, Alfred Brendel | 411 189-2 |
| Mozart: Violin Concerto No. 2/Academy of St. Martin-in-the- Fields, Brown | 411 613-2 ZH | Beethoven: Symphony No. 3 (Eroica)/Academy of St. Martin-in-the-Fields, Neville Marriner | 410 044-2 |
| Mussorgsky: Pictures/Ravel: Tombeau/ Chicago Symphony Orchestra, Georg Solti | 400 051-2 LH | Brahms: German Requiem/Vienna Philharmonic Orchestra, Bernard Haitink | 411 436-2 |
| New Year's Concert: Vienna Philharmonic Orchestra, Willi Boskovsky | 410 256-2 LH | Brahms: Hungarian Dances/Katia & Marielle Labegue | 411 426-2 |
| Offenbach: Gaite Parisienne/Gounod: Faust Ballet/Montreal Symphony Orchestra, Charles Dutoit | 411 708-2 LH | Bruckner: Symphony No. 9/Concertgebouw, Bernard Haitink | 410 039-2 |
| Pachelbel: Canon, etc./Academy of Ancient Music, Christopher Hogwood | 410 553-2 OH | Carreras: Ave Maria, Agnus Dei, etc/Vienna Boy's Choir | 411 138-2 |
| Pavarotti: Best Loved Tenor Arias | 400 053-2 LH | Carreras: Gregorian Chant | 411 140-2 |
| Pavarotti: O Sole Mio | 410 015-2 LH | Carreras: Popular Italian Songs | 400 015-2 |
| Pavarotti: Verismo Arias | 400 083-2 LH | Chopin: Piano Concerto No. 2/London Symphony Orchestra, Bella Davidovich, Neville Marriner | 410 042-2 |
| Pergolesi: Concerti Armonici/Academy of St. Martin-in-the- Fields, Neville Marriner | 410 205-2 LH | | |
| Prokofiev: Alexander Nevsky/Cleveland Orchestra, Riccardo Chailly | 410 164-2 LH | | |
| Prokofiev: Romeo/Classical Symphony/ Chicago Symphony Orchestra, Georg Solti | 410 200-2 LH | | |
| Puccini: Orchestral Works/Berlin Radio Symphony, Riccardo Chailly | 410 007-2 LH | | |
| Rachmaninov: Symphony No. 1 in d Minor, Op. 13/Concertgebouw Orchestra, Vladimir Ashkenazy | 411 657-2 LH | | |



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| Chopin: Waltzes/Claudio Arrau | 400 025-2 |
| Debussy: Jeux, Nocturnes/Concertgebouw, Bernard Haitink | 400 023-2 |
| Debussy/Ravel: String Quartet/Orlando Quartet | 411 050-2 |
| Dvorak: Serenades/Academy of St. Martin-in-the-Fields, Neville Marriner | 400 020-2 |
| Falla: Three-Cornered Hat/Pittsburgh Symphony, Andre Previn | 411 046-2 |
| Famous Spanish Dances: Pepe & Celin Romero | 411 432-2 |
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| Gershwin: Rhapsody In Blue/Warsaw Concerto, Dichter | 411 123-2 |
| Grieg: Peer Gynt/San Francisco Symphony, Edo de Waart | 411 038-2 |
| Handel: Messiah/J.E. Gardiner | 411 041-2 |
| Handel: 12 Concerti Grossi, Op. 6/Academy of St. Martin-in-the-Fields | 410 048-2 |
| Handel/Babell/Bastion: Recorder Concerti/ Academy of St. Martin-in-the-Fields, Michala Petri | 411 056-2 |
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| Liszt: Dante Sonata/Claudio Arrau | 411 055-2 |
| Liszt: Sonata in b Minor/Academy of St. Martin-in-the-Fields, Alfred Brendel | 410 040-2 |
| Mahler: Das Lied von der Erde/London Symphony Orchestra | 411 474-2 |
| Mahler: Symphony No. 7/Concertgebouw | 410 398-2 |
| Mahler: Symphony No. 8/Seiji Ozawa | 410 607-2 |
| Mendelssohn: Midsummer Night's Dream/ Philharmonia Orchestra, Neville Marriner | 411 106-2 |
| Mozart: Opera Arias/Kiri Te Kanawa | 411 148-2 |
| Mozart: Piano Concerti 15 & 21 (Elvira Madigan)/Academy of St. Martin-in-the-Fields, Alfred Brendel | 400 018-2 |
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| Mozart: Symphonies Nos. 39 & 41/Dresden State Orchestra, Colin Davis | 410 046-2 |
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| Ravel/Chabrier: Bolero, Espana/Dresden State Orchestra, Neville Marriner | 410 047-2 |
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| Rimsky-Korsakov: La Coq d'Or/Rotterdam Symphony, Zinman | 411 435-2 |
| Rimsky-Korsakov: Scheherazade/Concertgebouw, Kirill Kondrashin | 400 021-2 |
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| Schubert: An die Musik, Ella Amelie | 410 037-2 |
| Schubert: Impromptus/Alfred Brendel | 411 040-2 |
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| Schubert: Piano Quintet (Trout) Cleveland Quartet, Alfred Brendel | 400 078-2 |
| Schubert: Piano Sonatas D. 537 & 684/Alfred Brendel | 410 605-2 |
| Schubert: Schwanengesang/Alfred Brendel | 411 051-2 |
| Schubert: Symphonies 4 & 5/Academy of St. Martin-in-the-Fields, Marriner | 410 045-2 |
| Schubert: Symphony No. 8/Boston Symphony Orchestra | 410 393-2 |
| Schumann: Fantasiestucke/Alfred Brendel | 411 049-2 |
| Schumann: Symphony No. 3/Concertgebouw, Bernard Haitink | 411 104-2 |
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| Strauss: Ein Heldenleben/Seiji Ozawa | 400 073-2 |
| Strauss: Famous Waltzes/Vienna Philharmonic Orchestra | 411 119-2 |
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| Tchaikovsky: Nutcracker Suite/Academy of St. Martin-in-the-Fields, Marriner | 411 471-2 |
| Tchaikovsky: Piano Concerto No. 1/Bavarian Radio Orchestra, Martha Argerich | 411 057-2 |
| Tchaikovsky: Symphony No. 4/Pittsburgh Symphony, Andre Previn | 400 090-2 |
| Telemann: Suite in A Minor/Academy of St. Martin-in-the-Fields, Petri, Brown | 410 041-2 |
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PolyGram Records (Jazz)

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| Big Country: The Crossing | 812 870-2 |
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Steve Miller: Circle Love
Steve Miller: Greatest Hits
Steve Miller: Live
Van Morrison: Beautiful Vision
Van Morrison: Inarticulate Speech of the Heart
Van Morrison: Into the Music
Moody Blues: The Present
Nana Mouskouri: Nana
Nana Mouskouri: Songs of Liberty
Rainbow: Out of Shape
Rainbow: Straight Between the Eyes
Return of the Jedi: Original Soundtrack
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Roxy Music: Manifesto
Rush: Moving Pictures
Rush: Signals
Saturday Night Fever: Original Soundtrack
Star Wars: Original Soundtrack
Staying Alive: Original Soundtrack
Donna Summer: Walk Away
Tommy: Original Soundtrack
Vangelis: Antarctica
Vangelis: Chariots of Fire Soundtrack
Vangelis: China
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Zamfir: Music by Candlelight
Zamfir: Romance

Qwest Records (see Warner Communications)

RCA Records

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David Bowie: Young Americans
John Denver: Greatest Hits
John Denver: It's About Time
John Denver: Songs of the Heart
Eurythmics: Sweet Dreams (Are Made Of This)
Eurythmics: Touch
42nd Street: Original Cast Recording
James Galway: Annie's Song
Hall & Oates: Rock 'n' Soul, Part 1
Hard to Hold: Original Soundtrack
Hooked On Swing: Elgar
Jefferson Airplane: Surrealistic Pillow
Jefferson Starship: Nuclear Furniture
Jefferson Starship: Red Octopus
Jefferson Starship: Winds of Change
Waylon Jennings: Greatest Hits
Waylon Jennings/Willie Nelson/Jessie Colter/Tompall Glaser: The Outlaws
La Cage Aux Folles: Original Cast Recording
Louise Mandrell: Too Hot To Sleep
Ronnie Milsap: Greatest Hits
Ronnie Milsap: Inside RM
Ronnie Milsap: Keyed Up
Ronnie Milsap: No Getting Over Me
Harry Nilsson: Nilsson Schmilsson
Oliver: Original Cast Recording
Dolly Parton: Greatest Hits
Dolly Parton: The Great Pretender
Pointer Sisters: Break Out
Elvis Presley: Golden Records
Elvis Presley: Gold Records, Vol. 5
Elvis Presley: Limited Edition
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Beethoven: Symphony No. 9 in d Minor, Op. 125 (Choral)/New York Philharmonic, Zubin Mehta
Bizet: Carmen, Original Soundtrack/National Orchestra of France
Brahms: Concerto No. 1/Chicago Symphony Orchestra
Brahms: A German Requiem/Chicago Symphony Orchestra, James Levine
Canadian Brass: Hi, Brite, Lite
Canadian Brass: Greatest Hits
Dvorak: Symphony No. 9 (From The New World)/Chicago Symphony Orchestra, James Levine
Gershwin: An American In Paris, Cuban Overture, Porgy & Bess (A Symphonic Picture)/Dallas Symphony Orchestra, Eduardo Mata
Granados and Albeniz: Music of Spain/Julian Bream
Handel: Messiah (Highlights) Musica Sacra, Richard Westenburg
Handel: Water Music/John Eliot Gardiner/English Baroque Soloists
Holst: The Planets/Iso Tomita
Hooked On Classics: Royal Philharmonic Orchestra, Louis Clark
Hooked On Classics 2: Royal Philharmonic Orchestra, Louis Clark
Horowitz At The Met: Works by Scarlatti, Chopin, Liszt, and Rachmaninov
Hummel: Concerto for Trumpet in E Flat Major/Telemann: Concerto in D for 3 Trumpets/Neruda: Concerto for Trumpet/Orchestra Ensemble of Paris, Maurice Andre
Mahler: Symphony No. 7/Chicago Symphony Orchestra, James Levine
Mozart: Die Zauberflöte (Highlights)/Vienna Philharmonic Orchestra, James Levine
Mozart: Eine kleine Nachtmusik/Leppard
Mozart: Symphonies Nos. 40 & 41 (Jupiter)/Chicago Symphony Orchestra, James Levine
Mussorgsky: A Night On Bare Mountain/Dukas: Sorcerer's Apprentice/Tchaikovsky: Capriccio Italien/Enesco: Roumanian Rhapsody No. 1/Dallas Symphony Orchestra, Eduardo Mata
Offenbach: Canzon Burana/London Symphony Orchestra, Eduardo Mata
Pachelbel: Canon in D/Albinoni: Adagio/Works of Bach, Bonporti Molter/Chamber Orchestra, Jean Francois Paillard
Prokofiev: Peter and the Wolf/Britten: Young Person's Guide to the Orchestra/Philadelphia Orchestra/David Bowie
Rachmaninov: Concerto No. 2, Rhapsody on a Theme of Paganini/Chicago Symphony Orchestra
Rachmaninov: Concerto No. 3/Eugene Ormandy
Rameau: Orchestral Suite/Gardiner
Ravel: Bolero, Rapsodie Espagnole, Alborada del gracioso/Dallas Symphony Orchestra, James Levine
Sibelius: Violin Concerto/D. Jenson
Songs of the Seashore and other Melodies of Japan: Tokyo String Orchestra, James Galway
Strauss: Don Juan, Death & Transfiguration
Telemann: Music de Table
Vivaldi: 5 Concertos/I Solisti Veneti, Claudio Scimone
John Williams: Return of the Jedi/National Philharmonic Orchestra, Charles Gerhardt

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| De Falla: Three-Cornered Hat/Batiz | ACD4 |
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| Liszt: Dante Symphony/Tjeknavor | ACD1 |
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Sire Records

(see Warner Communications)

Southern Cross Records

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| Goossens | |
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| Tchaikovsky: Symphony No. 5/Malcolm Sargent | |

Supraphon Records

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| Dvorak: Symphony No. 7/Czech Symphony Orchestra, Neumann | CDS 7067 |
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| Dvorak: Symphony No. 9/Czech Symphony Orchestra, Neumann | CDS 7002 |
| Janacek: Sinfonietta/Neumann | CDS 7056 |

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| Beethoven: Piano Concerto No. 4/Boston Symphony, Seiji Ozawa | CD-80064 |
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St. Louis Symphony, Leonard Slatkin

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Symphony Orchestra and Chorus, Robert Shaw

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Prokofiev: Romeo & Juliet/Cleveland Orchestra

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Eugene Ormandy

Schubert: Symphony No. 8 Unfinished/Cleveland Orchestra,
Von Dohanyi

CD-80051

Schumann: Fantasy in C, Op. 17/Liszt: Rhapsodie Espagnole/
Schubert-Liszt Transcriptions/Nine Lechuk

CD-80075

Shostakovich: Symphony No. 5/Cleveland Orchestra, Lorin Maazel

CD-80067

Stars & Stripes: Famous Fanfares, Marches, & Wind Band
Spectaculars/Cleveland Symphonic Winds

CD-80099

Star Tracks: Music from the Star Wars Trilogy/Cincinnati Pops
Orchestra

CD-80094

Stravinsky: The Firebird/Atlanta Symphony, Robert Shaw

CD-80039

Stravinsky: Rite of Spring/Cleveland Orchestra, Lorin Maazel

CD-80054

Tchaikovsky: 1812 Overture, Capriccio Italien/Cincinnati Symphony,
Kunzel

CD-80041

Tchaikovsky: Nutcracker Suite/Romeo & Juliet/Cleveland Orchestra,
Lorin Maazel

CD-80068

Tchaikovsky: Symphony No. 4/Cleveland Orchestra, Lorin Maazel

CD-80047

Various Artists: Telarc CD Sampler I

CD-80101

Various Artists: Telarc CD Sampler II

CD-80102

Vaughan-Williams/Barber/Faure/Grainger: St. Louis Symphony,
Leonard Slatkin

CD-80059

Vivaldi: The Four Seasons/Boston Symphony, Silverstein

CD-80070

Wagner: Music of Wagner/Minneapolis Orchestra, Neville Marriner

CD-80083

Vanguard Recording Society

Joan Baez: Greatest Hits
Baltimore Symphony Orchestra: Sergiu Comissiona

K38YS

Saint Saens: Symphony No. 3, organ

K38Y17

Varese Sarabande Records

Adventures of Robin Hood

VRS 47202

Korngold: Kings Row

VRS 47203

John Williams: Star Wars Trilogy/Utah Symphony

VRS 47021

Warner Communications

Atlantic Records

| | |
|--|---------|
| Abba: Greatest Hits Volume I | 19114-2 |
| Abba: Greatest Hits Volume II | 10099-2 |
| Abba: The Singles | 80036-2 |
| Abba: The Visitor | 10032-2 |
| Beat Street: Original Soundtrack | 80154-2 |
| Laura Branigan: Branigan | 19289-2 |
| Laura Branigan: Branigan II | 80052-2 |
| Laura Branigan: Self Control | 80147-2 |
| Phil Collins: Face Value | 16029-2 |
| Phil Collins: Hello, I Must Be Going | 80035-2 |
| Crosby, Stills, & Nash: Allies | 80075-2 |
| Emerson, Lake, & Palmer: Pictures At An Exhibition | 19122-2 |
| Emerson, Lake, & Palmer: The Best of ELP | 19283-2 |
| Foreigner: Records | 80999-2 |
| Genesis: Abacab | 19313-2 |
| Genesis: And Then There Were Three | 19173-2 |
| Genesis: Duke | 16029-2 |
| Genesis: Genesis | 80116-2 |
| Freddie Hubbard: Sweet Returns | 80108-2 |
| Carole King: Speeding Time | 80118-2 |
| Led Zeppelin: Led Zeppelin | 19129-2 |
| Led Zeppelin: Symbols | 80084-2 |





| | |
|--|---------|
| Manhattan Transfer: The Best of... | 19319-2 |
| Manhattan Transfer: Bodies and Souls | 80104-2 |
| Bette Midler: No Frills | 80070-2 |
| Bette Midler: The Rose | 16010-2 |
| Stevie Nicks: Bella Donna | 90101-2 |
| Stevie Nicks: The Wild Heart | 90084-2 |
| Robert Plant: The Principle of Moments | 90101-2 |
| Jean-Luc Ponty: Individual Choice | 80098-2 |
| Rolling Stones: Still Life | 39113-2 |
| Tom Scott: Target | 80106-2 |
| Toni Tennille: More Than You Know | 90162-2 |
| Pete Townsend: Empty Glass | 32100-2 |
| Yes: 90125 | 90125-2 |

ECM Records

| | |
|--|---------|
| Chick Corea: Children's Song | 25005-2 |
| Chick Corea: Piano Improvisation | 31129-2 |
| Chick Corea: Return to Forever | 31128-2 |
| Chick Corea/Gary Burton: In Concert, Zurich, October 28, 1979 | 01182-2 |
| Charlie Haden/Carla Bley: Ballad of the Fallen | 23794-2 |
| Keith Jarrett: Changes | 01064-2 |
| Keith Jarrett: Köln Concert | 01115-2 |
| Keith Jarrett: My Song | 01180-2 |
| Pat Metheny: 80/81 | 01216-2 |
| Pat Metheny: Offramp | 01190-2 |
| Pat Metheny/Lyle May: As Falls Wichita, So Falls Wichita Falls | 23796-2 |
| Oregon: Oregon | 01129-2 |
| Steve Reich: Music for 18 Musicians | |

Elektra/Asylum Records

| | |
|--|---------|
| Jackson Browne: Lawyers In Love | 60268-2 |
| Lindsey Buckingham: Law and Order | 561-2 |
| The Cars: Candy O | 507-2 |
| The Cars: The Cars | 135-2 |
| The Cars: Heartbeat City | 60296-2 |
| The Cars: Shake It Up | 567-2 |
| Judy Collins: The Best of Judy Collins | 75030-2 |
| Judy Collins: Colors of the Day | 105-2 |
| Judy Collins: Judith | 74012-2 |
| Judy Collins: Wildflowers | 60303-2 |
| Digital Domain | 60269-2 |
| The Doors: Alive She Cried | 74007-2 |
| The Doors: The Doors | 75011-2 |
| The Doors: L.A. Woman | 75007-2 |
| The Doors: Morrison Hotel | 105-2 |
| Eagles: Greatest Hits 1971-1975 | 60205-2 |
| Eagles: Greatest Hits Volume II | 103-2 |
| Eagles: Hotel California | 508-2 |
| Eagles: The Long Run | 1039-2 |
| Eagles: One of These Nights | 1004-2 |
| Eagles: On The Border | 60346-2 |
| Howard Jones: Howard Jones | 60224-2 |
| Greg Kihn: Kihnsipriacy | 61001-2 |
| Joni Mitchell: Court and Spark | 64513-2 |
| Queen: The Game | 112-2 |
| Queen: News of the World | 60185-2 |
| Linda Ronstadt: Get Closer | 106-2 |
| Linda Ronstadt: Greatest Hits Volume 1 | 516-2 |
| Linda Ronstadt: Greatest Hits Volume 2 | 60260-2 |
| Linda Ronstadt: What's New | 28-2 |
| Shalamar: Friends | 109-2 |
| Carly Simon: The Best of Carly Simon | 562-2 |
| Grover Washington: Come Morning | 60175-2 |
| Grover Washington: Winelight | 64305-2 |

Elektra/Asylum/Musician Records

| | |
|------------------------------------|---------|
| Chick Corea: Again and Again | 60167-2 |
| The Griffith Park Collection | 60025-2 |
| Freddy Hubbard: Ride Like The Wind | 60029-2 |
| John Klemmer: Finesse | 60197-2 |
| Lee Ritenour: Rio | 60024-2 |
| Tom Scott: Desire | 60162-2 |
| Jimmy Smith: Off The Top | 60175-2 |
| Steps Ahead: Steps | 60168-2 |
| Sadao Watanabe: Fill Up the Night | 60297-2 |

Geffen Records

| | |
|---|--------|
| Asia: Alpha | 4008-2 |
| Asia: Asia | 2008-2 |
| Berlin: Love Life | 4025-2 |
| Irene Cara: What A Feeling | 4021-2 |
| Dreamgirls: Original Cast Recording | 2007-2 |
| Peter Gabriel: Security | 2011-2 |
| Sammy Hager: (New Album) | |
| Hagar, Schon, Aaronson, Shrieve: Through the Fire | 4023-2 |
| Don Henley: (New Album) | 4026-2 |
| Jennifer Holliday: Feel My Soul | 4014-2 |
| Elton John: Breaking Hearts | 4031-2 |
| Madness: Keep Moving | 4022-2 |
| Joni Mitchell: Wild Things | 35DP51 |
| Quarterflash: Quarterflash | 2003-2 |
| Quarterflash: Take Another Picture | 4011-2 |
| Donna Summer: Donna Summer | 2005-2 |
| Donna Summer: (New Album) | |
| Wang Chung: Points on the Curve | 4004-2 |
| Neil Young: Everybody's Rockin' | 4013-2 |

Island Records

| | |
|----------------------|---------|
| Robert Palmer: Pride | 90065-2 |
| U2: War | 90067-2 |

Nonesuch Records

| | |
|---|----------|
| Bach: Mass in b Minor/The Bach Ensemble, Rifkin | 79036-2 |
| Bach: Wedding Cantata | 79013-2 |
| Bleger/Luxon/Kipnis: The Notebook of Anna Magdalena Bach | 79020-2 |
| Brahms: Liebeslieder Waltzes/L.A. Vocal Ensemble | 79008-2 |
| Brahms: Serenade No. 1/L.A. Chamber Orchestra | 79065-2 |
| Calliope: Calliope Dances | 979039-2 |
| Del Tredici: In Memory of a Summer Day/St. Louis Symphony, Leonard Slatkin | 79043-2 |
| Dvorak: Czech Suite/Wind Serenade/L.A. Chamber Orchestra, Schwarz | 79044-2 |
| Dvorak: Legends/Rochester Philharmonic | 79066-2 |
| Dvorak: Violin Concerto, Romance, Mazurek/St. Louis Symphony, Leonard Slatkin | 79052-2 |
| Joel Grey/N.Y.C. Orchestra & Choir: Kurt Weill-Silverlake | 79003-2 |
| Richard Goode/Orpheus Chamber Orchestra: Mozart Piano Concertos Nos. 17 & 23 | 79042-2 |
| Moral Guneyman: The Most Popular Chopin | 90116-2 |
| Paul Jacobs: Plays Blues, Ballads, & Rags | 79006-2 |
| Paul Jacobs/Ursula Oppens: Stravinsky's Petrouchka | 79038-2 |
| Janacek: Idyll for String Orchestra/L.A. Chamber Orchestra | 79033-2 |
| Igor Kipnis: The Virtuoso Handel | 79037-2 |
| London Early Music Group: O Dolce Vita Mia | 79029-2 |
| Moore's Irish Melodies: Shelton, DeGaetani | 79059-2 |
| Mozart: 4 Quartets/Sequoia String Quartet | 79026-2 |
| Odessa Balalaikas: The Art of the Balalaika | 79034-2 |
| Schimmel: Tango Project | 79030-2 |
| Schwartz: American Music For Strings/L.A. Chamber Orchestra | 79002-2 |
| Schoenberg: Verklarte Nacht/Trio/Santa Fe Chamber Music Festival | 79028-2 |
| Schubert: Octet/Boston Symphony Chamber Players | 79046-2 |
| Sequoia String Quartet: Sequoia String Quartet | 79048-2 |
| Strauss: Duo Concertino/Honnerger: Concerto da Camera/L.A. Chamber Orchestra | 79018-2 |
| Tanglewood Festival Chorus/Weill: Recordare Dallapiccola, Canti di Prigoria | 79050-2 |
| Teresa Stratas: The Unknown Kurt Weill | 79019-2 |
| Thomson: Four Saints In Three Acts/Orchestra of Our Time | 79028-2 |
| Two To Tango: The Tango Project Vol. 2 | 79057-2 |
| The Western Wind: An Old Fashioned Christmas | 79053-2 |
| Vivaldi: Concerti and Sonatas for Two Violins/Aston Magna | 79056-2 |
| Vivaldi: Concerto/Sonatas/Musical Offering | 79067-2 |

Qwest Records

| | |
|--|---------|
| Patti Austin: Patti Austin | 23974-2 |
| Patti Austin: Every Home Should Have One | 03591-2 |
| James Ingram: It's Your Night | 23970-2 |

Sire Records

| | |
|-----------------------------------|---------|
| The Pretenders: Learning to Crawl | 23980-2 |
|-----------------------------------|---------|



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| The Pretenders: Pretenders | 06083-2 |
| Talking Heads: Fear of Music | 06076-2 |
| Talking Heads: Remain In Light | 06095-2 |
| Talking Heads: Speaking In Tongues | 23883-2 |

Warner Bros. Records (Popular)

| | |
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| Laurie Anderson: Big Science | 03674-2 |
| Laurie Anderson: Mister Heartbreak | 25077-2 |
| George Benson: Breezin' | 03111-2 |
| George Benson: Give Me the Night | 03453-2 |
| Chicago: Chicago 16 | 23689-2 |
| Chicago: Chicago 17 | 25060-2 |
| Eric Clapton: Money & Cigarettes | 23773-2 |
| A Clockwork Orange: Original Soundtrack | 02573-2 |
| Ry Cooder: Bop Til You Drop | 03358-2 |
| Christopher Cross: Christopher Cross | 03383-2 |
| Christopher Cross: Another Page | 23757-2 |
| Devo: Freedom of Choice | 03435-2 |
| Dire Straits: Alchemy | 25077-2 |
| Dire Straits: Communiqué | 03330-2 |
| Dire Straits: Dire Straits | 03266-2 |
| Dire Straits: Love Over Gold | 23728-2 |
| Dire Straits: Making Movies | 03480-2 |
| Doobie Brothers: Minute by Minute | 03193-2 |
| Donald Fagen: Nightly | 23698-2 |
| Fleetwood Mac: Fleetwood Mac | 02281-2 |
| Fleetwood Mac: Mirage | 23607-2 |
| Fleetwood Mac: Rumours | 03010-2 |
| Michael Franks: The Art of Tea | 02230-2 |
| Peter Gabriel: Peter Gabriel | 02011-2 |
| Emmylou Harris: Profile | 03258-2 |
| Emmylou Harris: White Shoes | 23961-2 |
| Al Jarreau: Breakin' Away | 03576-2 |
| Al Jarreau: Jarreau | 23801-2 |
| Al Jarreau: (New Album) | 25106-2 |
| Rickie Lee Jones: Rickie Lee Jones | 03296-2 |
| King Crimson: Beat | 03629-2 |
| King Crimson: Three of a Perfect Pair | 25071-2 |
| Kraftwerk: Computer World | 03549-2 |
| Kraftwerk: Techno Pop | 23682-2 |
| Michael McDonald: If That's What It Takes | 23703-2 |
| Christine McVie: Christine McVie | 23703-2 |
| Van Morrison: Moondance | 25059-2 |
| Randy Newman: Trouble in Paradise | 23755-2 |
| Van Dyke Parks: Jump | 23829-2 |
| Prince: Controversy | 03601-2 |
| Prince: 1999 | 23720-2 |
| Prince: Purple Rain Soundtrack | 25110-2 |
| Eddie Rabbit: Step By Step | 00532-2 |
| Roxy Music: Avalon | 23686-2 |
| David Sanborn: Voyeur | 03546-2 |
| Carly Simon: Hello Big Man | 23886-2 |
| Paul Simon: Hearts and Bones | 23942-2 |
| Rod Stewart: Camouflage | 25095-2 |
| Rod Stewart: Greatest Hits | 03373-2 |
| James Taylor: Sweet Baby James | 01843-2 |
| Van Halen: Diver Down | 03677-2 |
| Van Halen: 1984 | 23985-2 |
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| The Who: It's Hard | 23731-2 |
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| Neil Young: Harvest | 02277-2 |
| ZZ Top: Deguello | 03361-2 |
| ZZ Top: Eliminator | 23774-2 |

Windham Hill Records

| | |
|--|---------|
| William Ackerman: Passage | WD 1014 |
| William Ackerman: Past Light | WD 1028 |
| Alex de Grassi: Southern Exposure | WD 1030 |
| Michael Hedges: Aerial Boundaries | WD 1032 |
| Mark Isham: Vapor Drawings | WD 1027 |
| Shadowfax: Shadowdance | WD 1029 |
| Liz Story: Solid Colors | WD 1023 |
| Various Artists: An Evening With Windham Hill Live | WD 1026 |
| Various Artists: Windham Hill Sampler '82 | WD 1024 |
| George Winston: Autumn | WD 1012 |
| George Winston: December | WD 1025 |
| George Winston: Winter Into Spring | WD 1019 |



Note: All information was provided by the individual record companies, the Compact Disc Group, and Laury's Records Chicago, and is subject to change.

(Continued from p. 96.)

enclosures and testing them in a field on Long Island using my laboratory audio equipment. The result was absolutely amazing—a small cabinet that outperformed all but the largest of horn enclosures—and it made even the cheapest of speakers sound good.

We took our enclosure to Avery Fisher to see if he might be interested in marketing it for us. He and his engineers tested it and said yes. But the 4 percent royalty Avery offered didn't seem all that much. So we decided to go ahead on our own, even though we didn't have any money.

A \$1000 bank loan on a car gave us enough to have a woodworking shop make a few units. I put them into a local hi-fi store and they sold quickly. Within two years the Karlson Enclosure was the largest selling enclosure in the country, with seven factories making them for us. I handled the business end and Karlson worked on further designs—a 12-inch model, an 8-inch model, and so on.

As the sales and the money grew, some differences in philosophy between Karlson and me split our partnership. I wanted to go for growth and Karlson wanted a maximum, immediate payoff. We broke up, with Karlson running the company and me going into publishing. In a few months the company went broke, ending the supply of Karlson enclosures for the world. Not even the technology of the enclosure is in most of today's hi-fi books.

My publishing business, meanwhile, has been fun. I started out with a publication for ham radio operators: *73 Magazine*. Then, when the first

microcomputer was invented, I saw the need for a magazine to help that new industry grow, and *Byte* was born. *Byte*, which is now owned by McGraw-Hill, is the largest consumer magazine in the country (in editorial pages and total pages per issue, among other categories), according to a recent *Folio* survey. In third place is my *80 Micro* magazine for the TRS-80 computer—the first system-specific magazine. Two out of three isn't bad, eh? *Vogue* beat me out for second place.

Last year, as the largest publisher in the microcomputer field, I merged my seven monthly magazines (Wayne Green Publications Group) with those of CW Communications, the largest publisher in the entire computer field. My goal was to have enough money to be able to start magazines to help new technologies—such as digital audio—develop faster.

It's particularly exciting for me to be back in the hi-fi field again after all these years.

78-33-Whir

When I was a kid, the 12-inch RCA Red Label 78s, the classical records, cost \$1 each and ran about 10 minutes total. In terms of today's dollar, that's close to \$20, or the price of a CD with an hour of music. Along about the time I built up a good collection of classical and country 78s, the LP was invented. If 78s ever come back, I've got 'em all up in the attic waiting. Now, with the CD being as much an improvement over the LP as the LP was over the 78, I'm starting all over again.

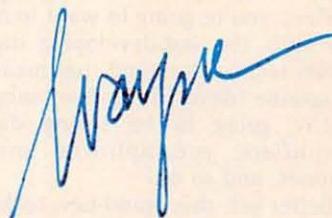
The first LPs were not very good

technically. It took several years before people like Cook and Weathers came along and made a fetish of hi-fi LPs. They did so well that larger firms got the hint. I suspect that we'll have the same situation with CDs. Perhaps this magazine will help by making it evident there is demand for the highest of quality in CDs. You have to back us up on this.

My LP collection has grown to more than 1000 discs, but I have a long way to go with CDs. I have only about 30 of them now—some pretty good, some fantastic, some disappointing. Fortunately for my pocketbook, my time for listening is limited these days, so I'm unlikely to replace more than just my particular favorites.

As for the future, will we be seeing rotary head digital audio tape recorders that use the regular Philips audio cassettes? It wouldn't surprise me if we eventually have digital Walkmans. We're entering a whole new world of audio and it's going to be fun.

An entire magazine devoted to the development of digital audio should speed up our technology. Let's hear from you—what you're doing, what you've invented, what CDs you like, and so on.



Skipping Up

Next Month: A Frank Discussion with Zappa

In October, *Digital Audio* explores "the studio side" of audio by talking to three of the field's experts—including Frank Zappa. *DA*'s technical editor, Steve Birchall, drops in on Zappa at his West Coast home—which doubles as an entirely digital recording studio. In an exclusive interview, Zappa discusses life, music, politics—and digital audio.

We'll also talk with Frank Dickin-

son and MacDonald Moore. As producer of Stevie Wonder's recent MTV special, Dickinson pioneered both the first digital audio telecast and first stereo telecast catered to the new stereo TV component systems. Moore, owner of a "have-digital-recording-equipment, will-travel" company in New York City, is currently one of the world's most experienced and respected independent digital recordists.

If you didn't make it to this summer's Consumer Electronics Show or Audio Engineering Society conference, relax—we'll fill you in on what you missed. *Digital Audio* returns to the scenes in October with a complete AES report and a follow-up to this month's CES coverage.

Compact Disc player reviews will include profiles of Sansui, Marantz, Onkyo, and Yamaha machines. You'll also find critiques of CD works by Thelma Houston, Amanda McBroom (two of the first artists featured on Sheffield Lab CDs), Stevie Nicks, Michael Jackson, Sonny Rollins, Stan Getz, Clifford Brown, English Beat, Strauss, Stravinsky, and others.



The Last Word

Why You Need This Magazine

by Wayne Green

Quantum Jump

After just one listen to a Compact Disc with earphones or on a good high fidelity system, you'll understand why digital audio will quickly put older recording techniques to rest.

Fine, but why would you want to read a magazine on the subject? If I didn't have a whale of an answer for that, I wouldn't have brought it up. Starting a new magazine is not a trivial investment in time and money these days, so you'd better believe that I think I've got you hooked right now.

First, you're going to want to keep up with the fast-developing digital audio technology—and that means a magazine devoted to the subject. We're going to be seeing digital amplifiers, preamplifiers, microphones, and so on.

Better yet, this brand-new technology is a great opportunity for new firms to start producing state-of-the-art equipment. A magazine like this is their connection to you, and you to them. Entrepreneurs are the heart and soul of America, but without a connection such as this magazine, most of the money would be filtered to large, established firms, and they, in general, are slower to embrace new technologies.

In addition, I hope it isn't news to you that a dismaying percentage of the Compact Discs issued so far haven't been very good or even completely digital. If I can save you from buying one bummer at around \$20 a whack, you're a winner.

With some 3000 CDs scheduled to be released this year, there obviously isn't any way we can keep up with that flood of material in our labs. We'll try, however, to review the most promising CDs for you, but the major

resource we can provide is a column for your personal evaluations.

In this issue you'll find a postcard to send in with your evaluations of any CDs you've bought recently. Please mark down the manufacturer, the disc number, and your evaluation of the disc from both performance and technical viewpoints. Use a scale of 0 to 10 in your rating (0 being terrible and 10 being superb). If you have any particularly cogent comments, note them.

A dismaying percentage of the Compact Discs issued so far haven't been very good or even completely digital. If I can save you from buying one bummer at around \$20 a whack, you're a winner.

We'll put your review data in our computer and run a printout each month of the discs, the votes for each, and the average vote for performance and technical quality. And yes, if we see some votes that seem to have been sent in by the manufacturer to weight your votes, we'll consider the source.

Who Am I?

Though I built my first audio

amplifiers in 1937, I didn't really get hung up with hi-fi until World War II (it was in the papers) threw my amateur radio hobby off the air.

At this time the largest parts firm in the business started selling a close-out lot of records from a defunct recording firm for 16 cents each. With most classical records at \$1, this was a bargain I couldn't pass up. I bought every one in their catalog, maybe 100 or so. These were 78s, obviously, and their quality was simply awful.

A few months after World War II started, the government developed an interest in my talents. It wanted to turn this shy, young electronics whiz into a certified U.S. Army killer. The government's Selective Service arguments were compelling, but I fooled 'em slightly by joining the navy and doing my killing from a submarine.

Picture me, if you will, going aboard a submarine with a homemade portable record player, a hi-fi amplifier complete with a built-in, 12-inch speaker, and a box of 50 classical records. I quickly discovered classical music wasn't a big hit with the ex-bread-delivery man from Altoona or his many, many friends with whom I was sailing. It was a culture clash. Jones, the radioman, solved the problem by folding my records so they wouldn't take up so much room.

By fast forwarding through college and a brief career in radio and television broadcasting, we arrive at my first entrepreneurial fling—a loudspeaker enclosure. While I was working for an electronics research firm, I met a chap, Karlson, who had invented a new kind of microwave antenna. Since microwaves and audio have the same wavelengths, why not use the new principle for a speaker cabinet?

We spent a summer making sample
(Continued on p. 95.)

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provides accurate disc rotation with
positive disc handling and loading.

Analog Domain Delta Power Supply
The important analog circuits
benefit from the clean DC source,
ensuring that the analog audio
output retains the full dynamic
range capabilities of the digital
compact disc.

Digital Domain Delta Power Supply
Provides the digital microprocessors
and Digital/Analog conversion
circuitry with a rock-steady DC
supply. This ensures that transient
voltage spikes and modulation noise
cannot interrupt the digital data bit
stream.



Display Delta Power Supply
Energizes the incandescent,
fluorescent, and LED components
of the front display panel, with
constant illumination.

The parameters of the Digital Audio Disc system provide for incredible audio performance, with wide dynamic range and ultra low distortion. Because Compact Disc players deal with purely digital audio signals it is commonly believed that no differences in sound quality exist between various CD players. However, much of the circuitry is devoted to the musical information after conversion to analog form. The Onkyo DX-300 Compact Disc Player employs separate Delta Power Supplies for each critical performance function to ensure that no extraneous noise or distortion affects the musical performance.

The Delta Power Supply, developed by Onkyo and used in our state-of-the-art amplifiers, pre-amplifiers, and other audio components, eliminates the low-level transient modulation noise caused by the interaction of musical signals with frequency components at or near the line charging frequency. This expands the available dynamic range a full 20 db over conventional analog power supplies, and provides a supply source with a dynamic range wide enough to match that of the digital audio source.

Onkyo's patented Delta Power Supplies, coupled with a highly sophisticated laser

tracking system and the most demanded convenience features, ensures that superb audio fidelity will always be realized. As the name "Integra" suggests, the DX-300 gives the listener a sound that's as close as possible to the original, with all the integrity of the live performance retained.

Artistry in Sound

ONKYO

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DQM SERIES



DAHLQUIST

FOR THOSE WHO QUESTION WHETHER DIGITAL IS READY, NOW THERE ARE FIVE WAYS TO FIND OUT.

The great digital debate is on. *Does the Compact Disc fulfill the digital promise? How does the CD measure up to the best of vinyl?*

Fortunately, the Dahlquist DQM series now has five high performance speaker systems to help you put digital to the test.

Dahlquist DQMs are as comfortable with digital's bold dynamics as they are with the subtleties of harmonic balance, ambience, fine detail and imaging in depth, so you can hear for yourself exactly what digital can (and perhaps cannot) do.

Not surprising, because the DQM series combines Dahlquist's years of experience in high-end audio with the most recent insights into studio monitor technology, acoustics and musicality.

There are five models in the DQM series,

ranging from \$200 to \$600 each. Every one, regardless of price, is constructed to an uncompromising standard of workmanship and materials.

The Dahlquist DQM Series—They're ready when you are.

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